PART 21-06 390 and 428 V8 Engines

MODEL APPLICATION—390—Ford, Mercury and Meteor
428—Cougar and Mustang
—Ford and Mercury Police

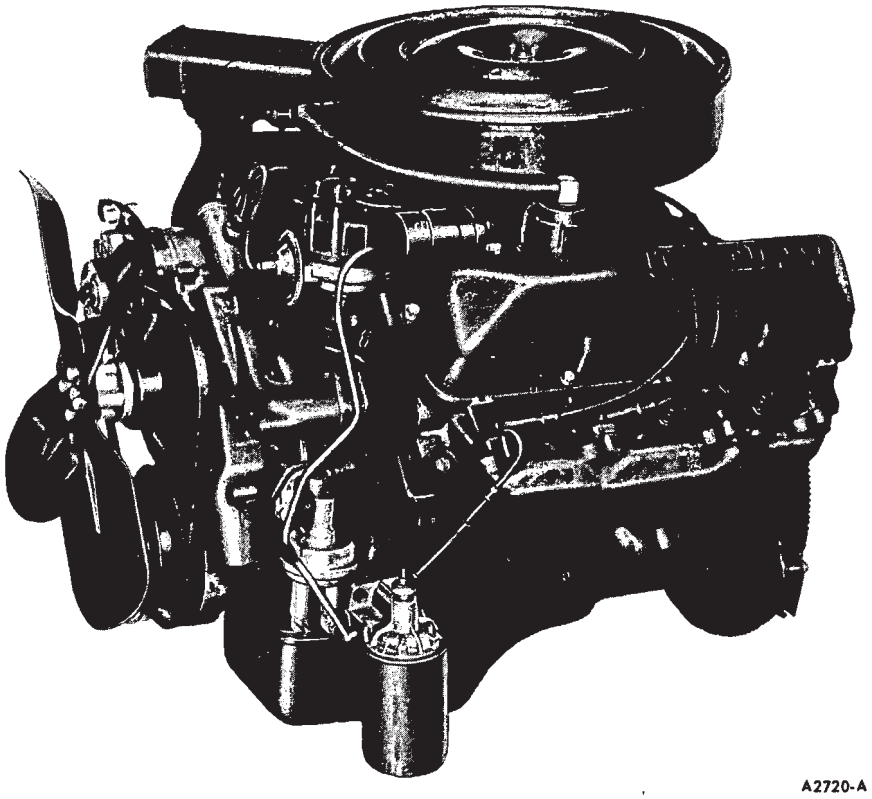

FIG. 1—390 2-V Left Front View-Imco

ENGINE

The 390 and the 428 V-8 engines (Figs. 1 and 2) have the same basic design. Differences in the engines are called out when they exist. Refer to Group 1 and Part 21-01 for the engine identification and application.

As engine identification tag is attached to the ignition coil bracket; refer to Part 21-01, Section 1 for the engine tag codes.

The 390 uses the Imco exhaust emission control system while the 428 4-V engine uses the Thermactor exhaust emission control system to keep exhaust gas contaminants at an acceptable level.

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

All 390 and 428 engines are equipped with a positive closed-type crankcase ventilation system. The positive closed-type crankcase ventilation system substantially reduces air pollutants emitted by the crankcase ventilating system.

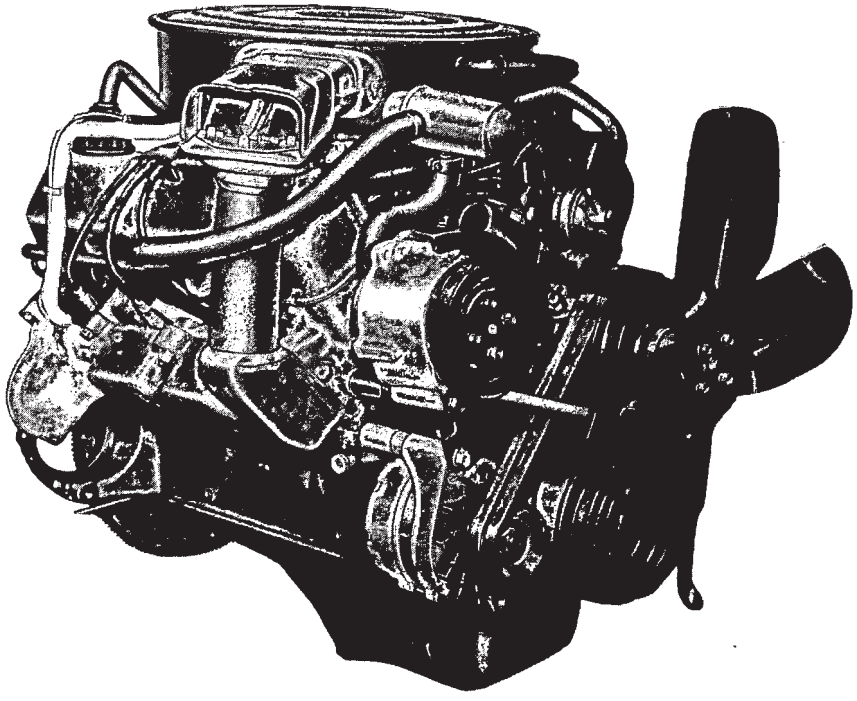

FIG. 2—390 or 428 3/4 Right Front View-Thermactor

2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

Refer to Part 21-03 for cleaning and inspection procedures.

Refer to Part 21-01, Section 1 for test procedures.

When installing nuts or bolts that must be torqued (refer to the pertinent Part for torque specifications), oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water resistant sealer.**

ENGINE SUPPORTS

The front supports are located on each side of the cylinder block and the rear support is located at the transmission extension housing (Fig. 3).

FORD-MERCURY 390-428 FRONT SUPPORT INSULATORS

The procedures given apply to either a right or left installation.

Removal

1. On a vehicle with an automatic transmission, remove the transmission oil cooler inlet and outlet tubes from the retaining bracket on the cylinder block.
2. Remove the insulator to intermediate support bracket lock nut. **If only one support is being removed, loosen the other support.**
3. Using a jack and a wood block placed under the oil pan, raise the engine to allow just enough clearance for removal of the insulator(s).
4. Remove the insulator to engine locking bolts. Remove the insulator.

Installation

1. Position the insulator assembly on the engine. Install the insulator to engine locking bolts finger-tight.
2. Lower the engine carefully to make sure the insulator stud engages the intermediate support bracket mounting hole.
3. Install the lock nut on the insulator stud. Torque the insulator nut and bolts to specifications.
4. If only one support was removed, tighten the other support.
5. On a vehicle with an automatic transmission, install the transmission oil cooler inlet and outlet tubes in the retaining bracket on the cylinder block.

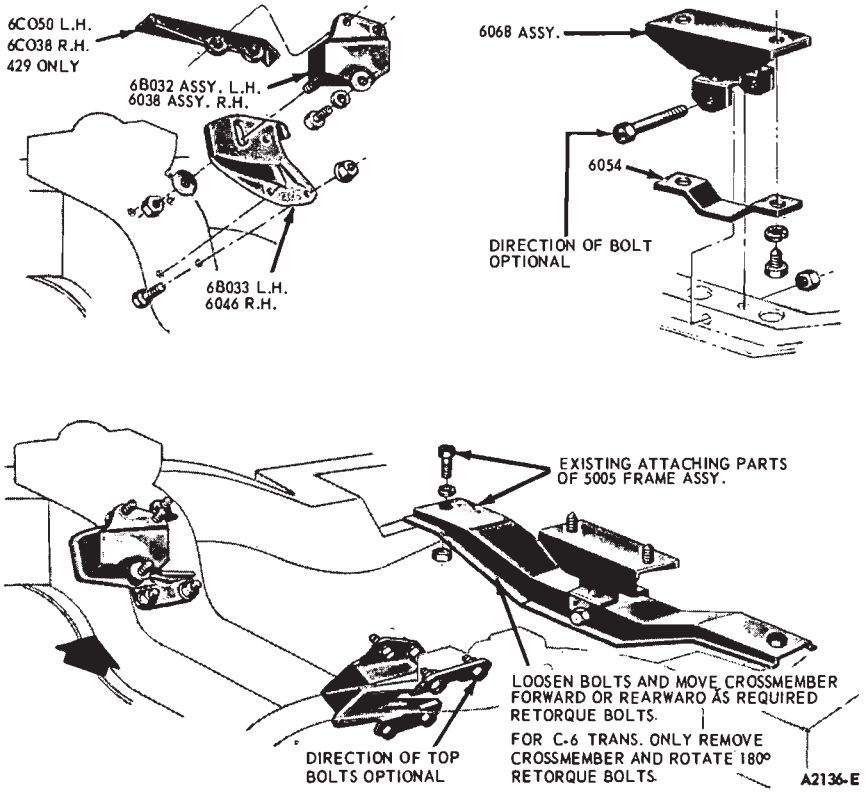

FIG. 3—Engine Front and Rear Supports—Ford-Mercury 390-428

FORD-MERCURY 390-428 REAR SUPPORT INSULATOR

Removal

1. Remove the attaching bolts, nut, washers and insulator retainer.
2. Raise the engine slightly to gain clearance and remove the insulator assembly.

Installation

1. Position the insulator assembly and retainer. Install the insulator to extension housing flat washers, lock washers and bolts.
2. Lower the engine and install the insulator to frame crossmember bolt. If necessary, loosen the crossmember-to-frame mounting bolts and move the crossmember forward or rearward as required. Torque the insulator-to-frame crossmember and crossmember-to-frame mounting nuts and bolts to specifications.

MUSTANG-COUGAR 428CJ FRONT SUPPORT INSULATORS

The procedures given apply to both right and left insulators.

Removal

(Refer to Figure 4)

1. Remove the air cleaner assembly.
2. Remove the bolts attaching the radiator shroud and leave it loose to allow fan clearance when raising the engine.
3. Remove the upper nut attaching the carburetor heat stove to the right exhaust manifold.
4. Raise the vehicle.
5. Remove the lower nut attaching the carburetor heat stove to the right exhaust manifold. Rotate the stove up and around the front of the manifold and position it under the battery carrier, out of the way.
6. Disconnect the power steering oil cooler lines at the engine oil filter adapter.
7. Remove the power steering line retainer and position lines out of the

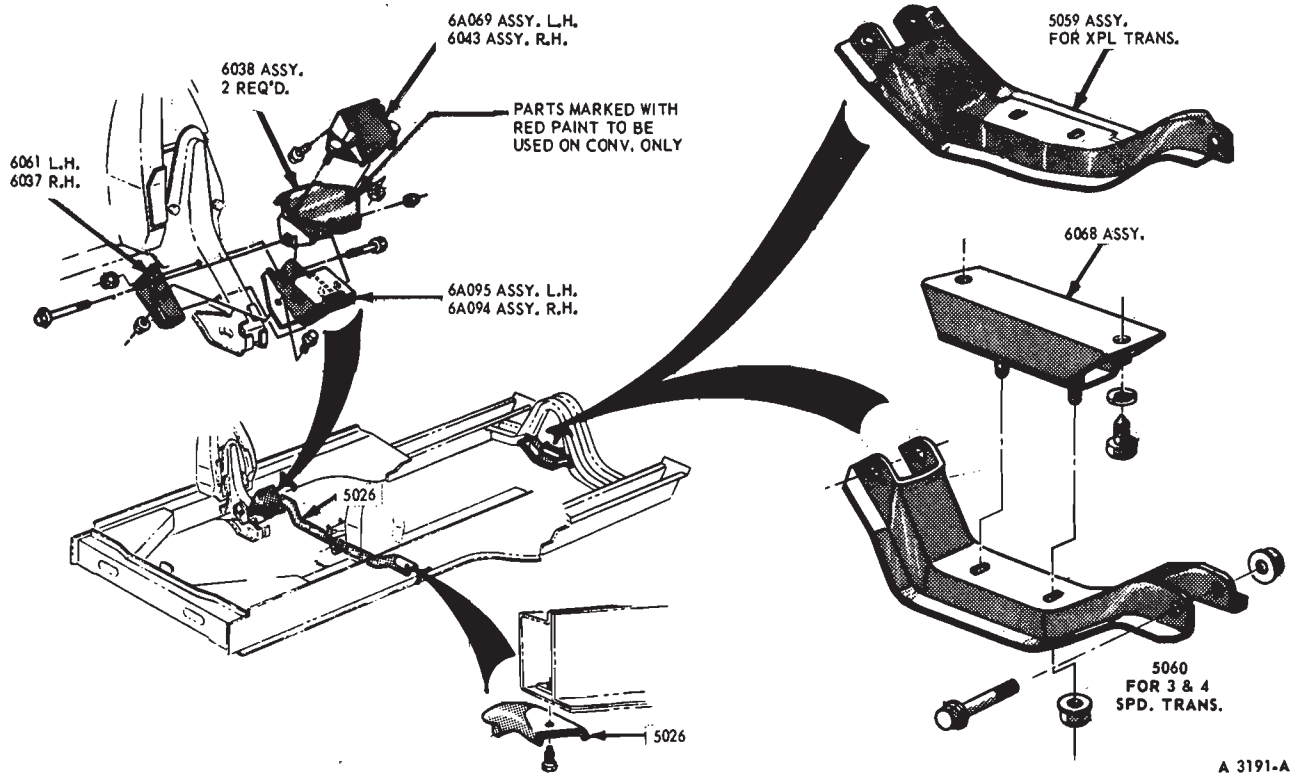

FIG. 4—Engine Front and Rear Supports—Mustang-Cougar 428 CJ

way.

8. Position a floor jack under the engine.

9. Place a wood block between the oil pan and the jack and raise the engine slightly.

10. Remove the engine support to chassis thru bolt and nut on either or both sides.

11. Remove nuts and bolts attaching the engine support bracket to the chassis on either or both sides. Raise the engine.

12. Remove the nuts attaching the engine support insulators to the engine brackets and remove the insulators.

Installation

(Refer to Figure 4)

1. Position engine support insulator to the cylinder block bracket and install the attaching nuts. Torque to specifications.

2. Position engine support insulator to the chassis bracket and install attaching bolts and nuts. Torque to specifications.

3. Lower the jack enough to line up the holes and install the engine support to chassis thru bolt. Lower the engine completely and torque the thru bolt nut to specification.

4. Position the power steering line retainer to chassis and install attaching bolt.

5. Connect the power steering oil cooler line at the engine oil filter adapter.

6. Reposition the carburetor stove to the exhaust manifold and install the lower attaching nut.

7. Lower the vehicle.

8. Install the upper carburetor stove attaching nut.

9. Position the radiator shroud to the radiator and install the attaching bolts.

10. Install the air cleaner assembly.

MUSTANG-COUGAR 428CJ REAR SUPPORT INSULATOR

(Refer to Figure 4)

Removal

1. Raise the vehicle. Position a jack under the engine with a block of wood between the jack and the oil pan. Raise the engine enough to take the weight off the insulator.

2. Remove the nuts attaching the insulator to the removable cross-member.

3. Remove the thru-bolts attaching the cross-member to the frame and remove the cross-member.

4. Remove the bolts attaching the support insulator to the transmission extension housing and remove the insulator.

Installation

1. Position the support insulator to the transmission extension housing and install and torque the attaching bolts.

2. Loosely install the cross-member to the lower insulator studs.

3. Raise the engine as necessary and install the cross-member to the chassis with the thru-bolts. Torque the thru-bolt nuts to specifications.

4. Lower the engine and tighten and torque the rear support attaching nuts.

5. Remove the jack and lower the car.

THERMACTOR AIR PUMP DRIVE BELT ADJUSTMENT

The air supply pump drive belt should be properly adjusted at all times. A loose drive belt causes improper air pump operation. A belt that is too tight places a severe strain on the air pump bearings.

Properly tensioned drive belts mini-

mize noise and also prolong service life of the belt. A belt tension gauge should be used to adjust and check the bdlt tension. **Any belt that has operated for a minimum of 10 minutes is considered a used belt, and, when adjusted, it must be adjusted to the tension shown in the specifications for used belts.**

BELT TENSION

1. Install the belt tension tool (T63L-8620-A) on the drive belt and check the tension following the instructions of the tool manufacturer. Compare the belt tension to the specified belt tension and adjust as necessary.
2. If adjustment is necessary, loosen the air pump mounting and adjusting arm bolts (Fig. 5). Move the air pump toward or away from the engine until the correct tension is obtained. **Use a suitable bar and pry against the pump rear cover** to hold belt tension while tightening the mounting bolts. **Do not pry against the pump housing.** Remove the gauge. Tighten the air pump adjusting arm and mounting bolts. Install the tension gauge and check the belt tension.

THERMACTOR AIR PUMP DRIVE BELT REPLACEMENT

1. Loosen the air supply pump adjusting arm bolt (Fig. 5). Loosen the air supply pump to mounting bracket bolt, and push the air pump towards the cylinder block. Remove the drive belt.
2. Install a new drive belt. With a suitable bar, **pry against the rear cover of the air pump** to obtain the specified belt tension (refer to pertinent Part), and tighten the adjusting arm bolt. **Do not pry against the pump housing.** Adjust the belt tension (refer to pertinent Part) as necessary. **Always use a belt tension gauge (Tool T63L-8620-A) to check belt tension.**
3. Tighten the air supply pump to mounting bracket bolt.

THERMACTOR AIR BYPASS VALVE REPLACEMENT

1. Disconnect the air and vacuum hoses at the air bypass valve body (Fig. 5), and remove the valve.
2. Position the air bypass valve properly, and connect the air and vacuum hoses.

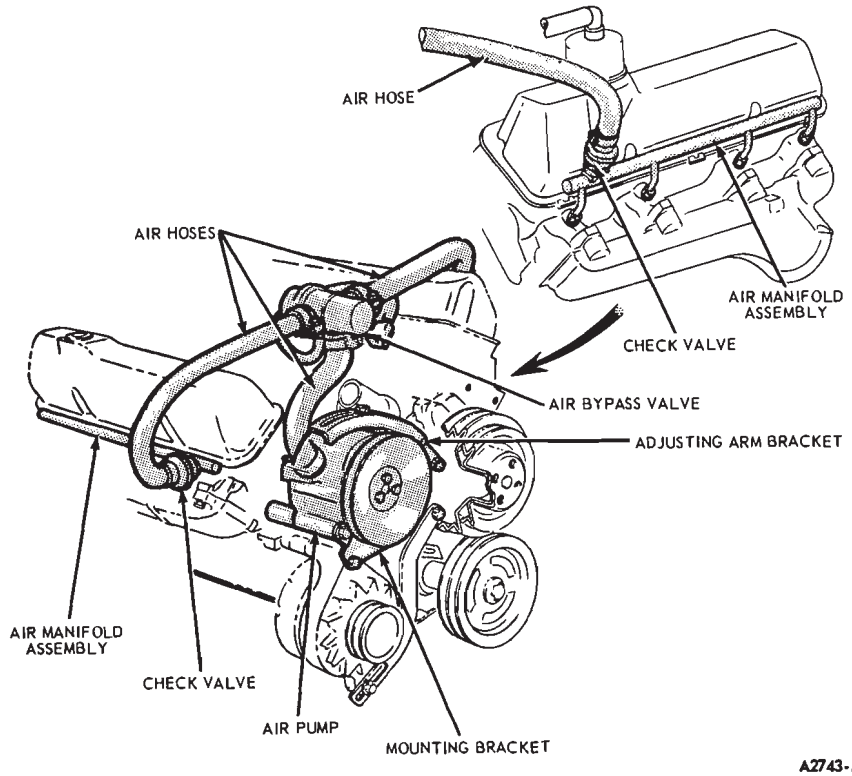

FIG. 5—Thermactor Exhaust Emission System Installation

THERMACTOR CHECK VALVE REPLACEMENT

1. Disconnect the air supply hose at the valve. Use a 1-1/4 inch crowfoot wrench to unscrew the check valve assembly (the valve has a standard, pipe thread).
2. Clean the threads on the air manifold adapter with a wire brush. Install the check valve and torque it to specifications. Connect the air supply hose.

THERMACTOR AIR MANIFOLD

REMOVAL

1. Disconnect the air supply hose at the check valve and position the hose out of the way.
2. Loosen all of the air manifold to cylinder head tube coupling nuts (compression fittings). Then unscrew each one until it is free of the cylinder head. Grasp the air manifold at each end and pull it away from the cylinder head. Follow the same procedure to remove the other air manifold, if the engine is so equipped.

INSTALLATION

1. Position the air manifold(s) on the cylinder head. Be sure all the tube coupling nuts are aligned with the cylinder head. Screw each coupling nut into the cylinder head 1 to 2 threads. Tighten the tube coupling nuts.
2. Connect the air supply hose to the air manifold.

THERMACTOR AIR SUPPLY TUBE REPLACEMENT

Normally, air supply tubes would be replaced as necessary during cylinder head overhaul. A supply tube may

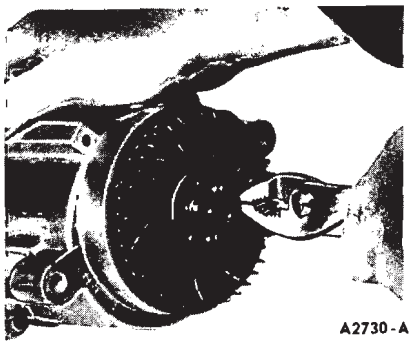

FIG. 6—Removing Thermactor Air Pump Centrifugal Filter Fan

be replaced without removing the cylinder head by removing the air manifold and using a hooked tool to pull the supply tubes.

For cleaning and inspection refer to Part 21-01, Section 3. Additionally, the air supply tubes could be inspected for badly eroded tips with the aid of a mirror, when the exhaust manifold(s) is removed.

THERMACTOR AIR PUMP DRIVE PULLEY REPLACEMENT

1. Loosen the air supply pump adjusting arm and mounting bolts to relieve the belt tension.
2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.
3. Position the drive pulley on the air supply pump shaft, and install the attaching bolts. Torque the bolts to specifications.
4. Position the drive belt and adjust the belt tension to specifications. Tighten the adjusting arm and mounting bolts.

THERMACTOR AIR PUMP CENTRIFUGAL FILTER FAN REPLACEMENT

1. Loosen the air supply pump adjusting arm bolt and mounting bracket bolt to relieve drive belt tension.
2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.
3. Pry the outer disc loose and then pull off the centrifugal filter fan as shown in Fig. 6. Care should be taken to prevent fragments from entering the air intake hole if the fan breaks when removing. **Do not attempt to remove the metal drive hub.**
4. Install the new filter fan by drawing it into position, using the pulley and bolts as an installer. Draw the fan evenly by alternately tightening the bolts, making certain that the outer edge of the fan slips into the housing.

A slight amount of interference with the housing bore is normal, and some initial noise during run-in may be expected.

THERMACTOR AIR SUPPLY PUMP

REMOVAL

1. Disconnect the air outlet hose at the air pump.
2. Loosen the adjusting arm to air pump and air pump to mounting bracket bolts to relieve the drive belt tension.
3. Disengage the drive belt. Remove the mounting bolt and air pump.

INSTALLATION

1. Position the air pump on the mounting bracket and install the mounting bolt.
2. Place the drive belt in the pulleys and attach the adjusting arm to the air pump. Adjust the drive belt tension to specifications and tighten the adjusting arm and mounting bolts.
3. Connect the air outlet hose to the air pump.

THERMACTOR AIR PUMP RELIEF VALVE REPLACEMENT

Do not disassemble the air pump to replace the relief valve, but remove it from the engine.

1. Position Tool T66L-9A486-D on the air pump and remove the relief valve with the aid of a slide hammer (T59L-100-B).
2. Position the relief valve on the pump housing and hold Tool T66L-9A486-B on the relief valve. Use a hammer to **tap the tool lightly** until the relief valve is seated.

THERMACTOR RELIEF VALVE PRESSURE-SETTING PLUG REPLACEMENT

1. Compress the three locking tabs inward (together) and remove the plastic pressure-setting plug.
2. Before installing the new plug, be sure that the plug is the correct one. The correct plug for this engine should be color-coded blue.
3. Insert the plug in the relief valve hole, and push the plug in until it snaps into place.

VALVE ROCKER ARM SHAFT ASSEMBLY

REMOVAL

1. Remove the air cleaner.
2. On Thermactor engines, disconnect the air hoses as necessary for accessibility and position them out of the way.
3. Disconnect the spark plug wires at the spark plugs. Remove the wires from the bracket on the valve rocker arm cover(s) and position the wires out of the way.

To remove the right valve rocker arm cover, remove the carburetor choke air heat tube, and the heat chamber air inlet tube. Remove the crankcase ventilation regulator valve or vent tube from the rocker cover.

4. Remove the valve rocker arm cover(s).

If the left cover is removed, position the wire loom out of the way.

5. Crank the engine until the No. 1 piston is on TDC at the end of the compression stroke. Rotate the crankshaft damper an additional 45 degrees (identified by XX on the damper).
6. On the right cylinder head, start at the No. 4 cylinder and loosen the valve rocker arm shaft support bolts in sequence, two turns at a time. After the bolts are all loosened, remove the valve rocker arm shaft assembly and the oil baffle plate. On the left cylinder head, start at the No. 5 cylinder and follow the same procedure on the left valve rocker arm shaft support bolts. **This procedure must be followed to avoid damage to the rocker shaft.**

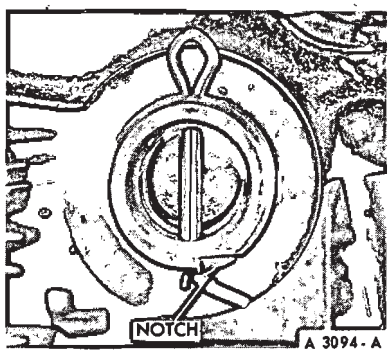

FIG. 7—Typical Installation Identification Mark-Rocker Arm Shaft Assembly

INSTALLATION

1. Apply Lubriplate to the pad end of the rocker arms, to the tip of the valve stems, and to bolt ends of the push rods.
2. If the crankshaft damper has been removed, reposition it on the XX mark, following the procedure under Step 4 of Removal above.
3. Position the baffle plate and the valve rocker arm shaft assembly(ies) on the cylinder heads with the valve push rods in place and the rocker shaft support bolts finger-tight. **Be sure the shaft is positioned so that the oil holes are to the bottom. Also, the identification notch (Fig.7) must be downward and toward the front on the right bank, or toward the rear on the left bank.**

4. On the right cylinder head, start at the No. 4 cylinder and tighten the bolts in sequence, two turns at a time, until the supports fully contact the cylinder head. Torque the bolts in sequence to specifications.

5. On the left cylinder head, start at the No. 5 cylinder and follow the same procedure for the left valve rocker arm shaft support bolts. The additional time consumed in this procedure will permit the hydraulic lifters to leak down. This willminimize the possibility of bending the push rods, valves or rocker arms. **Be sure that the hydraulic lifters have leaked down to their normal operating position before cranking the engine. This is necessary in order to avoid possible damage to the valves, push rods or valve rocker arms.**

6. Clean the valve rocker arm cover(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s).

7. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts (and the wire loom clamps on the left cover). The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

On a vehicle with power brakes, if the left cover was removed, connect the brake booster vacuum line to the intake manifold. On Thermactor engines connect the air hoses.

If the right cover was removed, install the carburetor choke air heat tube, and connect the automatic choke heat chamber air inlet tube. Install the crankcase ventilation regulator valve in the rocker cover.

8. Connect the spark plug wires. Install the air cleaner.

DISASSEMBLY

1. Remove the cotter pins from each end of the valve rocker arm shaft. Remove the flat washer and spring washer from each end of the shaft.

2. Slide the rocker arms, springs and supports off the shaft. Be sure to identify all the parts.

3. If it is necessary to remove the plugs from each end of the shaft, drill or pierce one plug. Then insert a steel rod through the drilled plug and knock out the plug on the opposite end. Working from the open end, knock out the remaining plug.

ASSEMBLY

1. Oil all the moving parts including valve stems with engine oil. Apply Lubriplate to the pad of the valve rocker arms.

2. If the plugs were removed from the ends of the shaft, use a blunt tool or large diameter pin punch, and install a plug, cup side out, in each end of the rocker arm shaft.

3. Install the rocker arms, supports and springs in the order shown in Fig. 8. **Be sure the oil holes in the shaft are facing downward. When properly assembled, the identification notch (Fig. 7) on the right rocker shaft assembly must be facing downward and toward the front of the engine. On the left rocker shaft, the notch is downward and toward the rear.** Complete the assembly by installing the remaining flat washer, spring washer and cotter pin.

INTAKE MANIFOLD

REMOVAL

1. Drain the cooling system. Remove the hood. Remove the air cleaner.

Disconnect the accelerator cable at the carburetor. Remove the accelerator retracting spring. Remove the accelerator cable bracket from the intake manifold, and position the cable and bracket assembly out of the way.

On a vehicle with an automatic transmission, remove the kickdown rod retracting spring. Disconnect the kickdown rod at the carburetor and the spacer vacuum line.

2. Disconnect the coil high tension lead and the primary wire at the distributor. Disconnect the oil pressure sending unit wire at the sending unit.

3. Disconnect the spark splug wires at the spark plugs and remove the wires from the ignition harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wires as an assembly. Disconnect the distributor vacuum hoses at the distributor.

4. Disconnect the carburetor fuel inlet line at the fuel filter. Remove the automatic choke air heat tube and the heat chamber air inlet tube. Disconnect the brake booster vacuum line at the intake manifold and at the flexible hose. Remove the vacuum line.

5. Remove the distributor hold down bolt and clamp, and remove the distributor.

6. Disconnect the radiator upper hose at the thermostat housing. Disconnect the heater hoses from the intake manifold. Disconnect the water

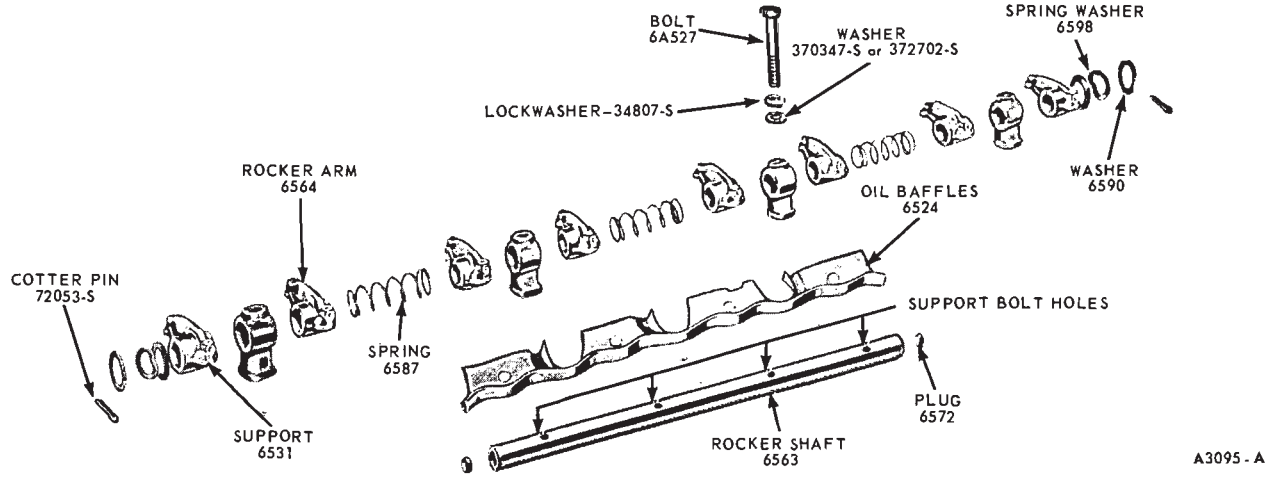

FIG. 8—Valve Rocker Arm Shaft Assembly

temperature sending unit wire at the sending unit. Disconnect the heater hose at the water pump and remove it from the automatic choke housing bracket.

7. Loosen the clamp on the water pump bypass hose, and slide it toward the water pump.

8. Remove the crankcase ventilation regulator valve from the right valve rocker arm cover. On Thermactor engines, disconnect the air lines and hoses as necessary for accessibility. Remove the valve rocker arm covers. Position the wire loom attached to the left valve rocker arm cover out of the way.

9. Refer to Valve Rocker Arm Shaft Assembly—Removal, and remove the valve rocker arm shaft assemblies by following steps 4 and 5.

10. Remove the valve push rods in sequence, and place them in a rack so they can be installed in the same location.

11. Remove the intake manifold attaching bolts.

12. Install standard eye bolts with 5/16-18 threads in the left front and right rear rocker arm cover screw holes and attach the engine lifting sling (Fig. 9).

13. Use a hoist to raise the manifold. Remove the intake manifold. Remove the intake manifold gaskets and seals.

14. If the intake manifold is to be disassembled, identify the distributor vacuum hoses to facilitate proper connection; then remove the hoses. Remove the thermostat housing, thermostat and gasket. Remove the carburetor, spacer and gaskets. Remove the coolant temperature sending unit.

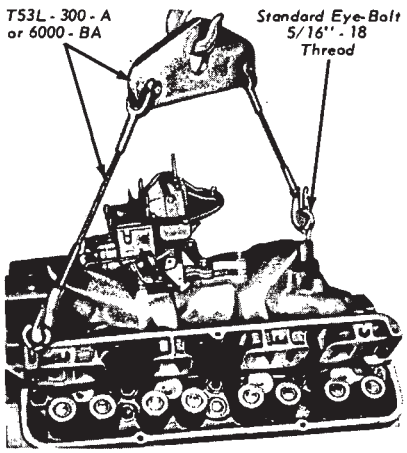

FIG. 9—Removing or Installing Intake Manifold

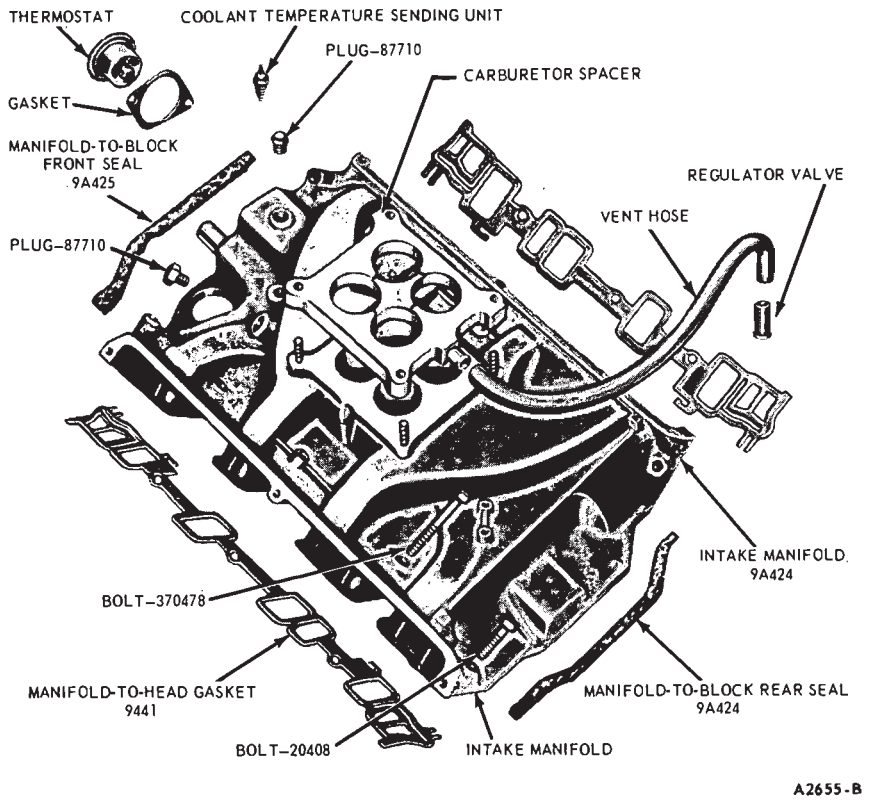

FIG. 10—Typical Intake Manifold Assembly 390 and 428 V-8, Except 428 Police

INSTALLATION

The intake manifold assembly is shown in Fig. 10.

1. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil.

2. If the intake manifold was disassembled, install the carburetor, spacer and gaskets. Coat the thermostat gasket with water-resistant sealer and place it in position on the intake manifold. Install the thermostat and thermostat housing. Coat the coolant temperature sending unit threads with electrical conductive sealer, and install the sending unit in the intake manifold. Install the distributor vacuum hoses. Be sure the hoses are properly connected.

3. Coat the intake manifold and cylinder block seal surfaces with contact cement. Apply a non-hardening sealer to the mating lines of the cylinder heads and cylinder block.

4. Position new seals on the cylinder block and new gaskets on the cylinder heads. **Be sure the seals are properly positioned during installation as the adhesive sticks to the seals immediately on contact.** Position the manifold gasket slots over the end tabs on the seals. Coat these four connections with a non-hardening sealer. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

5. Install the eye bolts in the intake manifold and attach the engine lifting sling.

6. Use a hoist to lower the intake manifold on the engine (Fig. 9), and at the same time engage the coolant outlet nipple with the water pump bypass hose.

7. **After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and reposition the seals.**

8. Be sure the holes in the manifold gaskets and manifold are in alignment. Coat the underside of the heads of the attaching bolts with oil-resistant, non-hardening sealer.

9. Install the distributor (as detailed in Group 22) to properly locate the manifold on the cylinder block. Install the manifold bolts. Torque the intake manifold bolts in two steps (Fig. 11).

Torque all bolts in sequence to specifications.

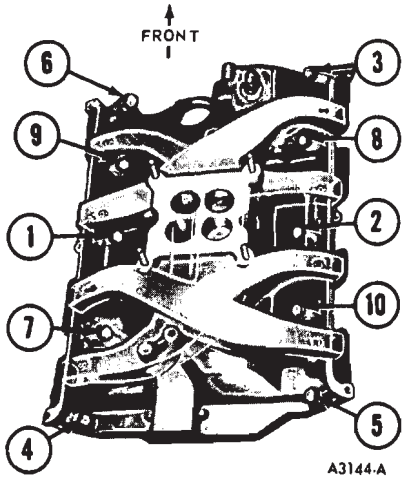

FIG. 11—Intake Manifold Torque Sequence

After completing the remaining assembly steps; operate the engine until it reaches normal operating temperature; then retorque the manifold bolts in sequence to specifications.

10. Remove the engine lifting sling and eye bolts.

11. Slide the water pump bypass hose clamp into position. Connect the coolant temperature sending unit wire. Connect the heater hoses and the radiator upper hose. Install the water pump heater hose in the automatic choke housing bracket.

12. Refer to Valve Rocker Arm Shaft Assembly Installation, and install the valve rocker arm shaft assembly by following steps 1 thru 7.

13. Clean the valve rocker arm covers. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers. Install the valve rocker arm covers, bolts and wire loom clamps. Tighten the covers in two steps. First, torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

14. Install the positive crankcase ventilation system components. On Thermactor engines connect the hoses.

15. Connect the brake booster vacuum line and connect the flexible hose.

16. Using a new clamp, connect the carburetor fuel inlet line to the fuel filter; then connect the distributor vacuum hoses. Be sure the vacuum hoses are properly connected. Install the automatic choke air heat tube and air inlet tube.

17. Install the distributor cap. Connect the spark plug wires.

18. Connect the oil pressure sending unit wire, coolant temperature sending unit wire, coil high tension lead and coil primary wire.

Install the accelerator cable bracket on the intake manifold. Connect the accelerator cable to the carburetor. Install the accelerator retracting spring.

On a vehicle with an automatic transmission, connect the kickdown rod. Install the kickdown rod retracting spring, and the spacer vacuum line.

19. Fill and bleed the cooling system.

20. Install the air cleaner, start the engine, and check and adjust the ignition timing. Operate the engine until engine temperatures have stabilized and adjust the engine idle speed and idle fuel mixture. Retorque the intake manifold bolts to specifications.

21. Install the hood.

EXHAUST MANIFOLDS

FORD-MERCURY 390-428

Removal

1. Disconnect the exhaust manifold from the muffler inlet pipe.

2. Remove the automatic choke air heat tube and air inlet tube from the right exhaust manifold.

3. Remove the attaching bolts and flat washers and remove the exhaust manifolds.

Installation

1. Clean the mating surfaces of the exhaust manifold and cylinder head. Scrape the gasket material from the mounting flange of the exhaust manifold and muffler inlet pipe.

2. Apply graphite grease to the cylinder head mating surface of the exhaust manifold.

3. Position the exhaust manifold on the cylinder head and install the attaching bolts and flat washers. Working from the center to the ends, torque the attaching bolts to specifications.

4. Install the automatic choke air heat tube and air inlet tube on the right exhaust manifold.

5. Position a new gasket between the exhaust manifold and the muffler inlet pipe. Install and torque the attaching nuts to specifications.

6. Start the engine and check for exhaust leaks.

EXHAUST MANIFOLDS

MUSTANG AND COUGAR 428 CJ

Removal

1. Remove the air cleaner, heat shroud and brackets, choke and vacuum tubes from the carburetor and exhaust manifold. Remove the 2 studs as they are manifold attaching bolts (right side).

2. Remove the 3 forward manifold attaching bolts (right side).

3. Raise the vehicle.

4. Remove the idler arm bracket from the frame and lower it to obtain clearance.

5. Disconnect the starter cable and remove the starter.

6. Remove the remaining manifold bolts (right side).

7. Remove the rear hanger clamps on outlet pipes, and the bolts on the muffler hangers.

8. Remove both inlet pipes from the manifolds.

9. Remove the Pitman arm from sector shaft, as detailed in Group 13.

10. On vehicles having power steering, remove the cylinder bracket from the frame for clearance.

11. Lower the exhaust system.

12. If removing the left manifold on a vehicle having a manual transmission, disconnect the clutch linkage and equalizer bracket from the engine.

13. Position a jack and wood block under the oil pan. Raise the engine slightly.

14. Remove the insulator brackets from the crossmember.

15. Remove the right and left insulators from the engine.

16. If removing the left manifold, remove the flex coupling at the steering shaft. Remove the steering gear from the frame.

17. If removing a left manifold, remove the attaching bolts and remove the manifold. The right manifold can be removed at this point.

Installation

1. Clean the mating surfaces of the exhaust manifold and cylinder head. Scrape the gasket material from the mounting flange of the exhaust manifold and muffler inlet pipe.

2. Apply graphite grease to the cylinder head mating surface of the exhaust manifold.

3. Install the left manifold, position right manifold to cylinder head and

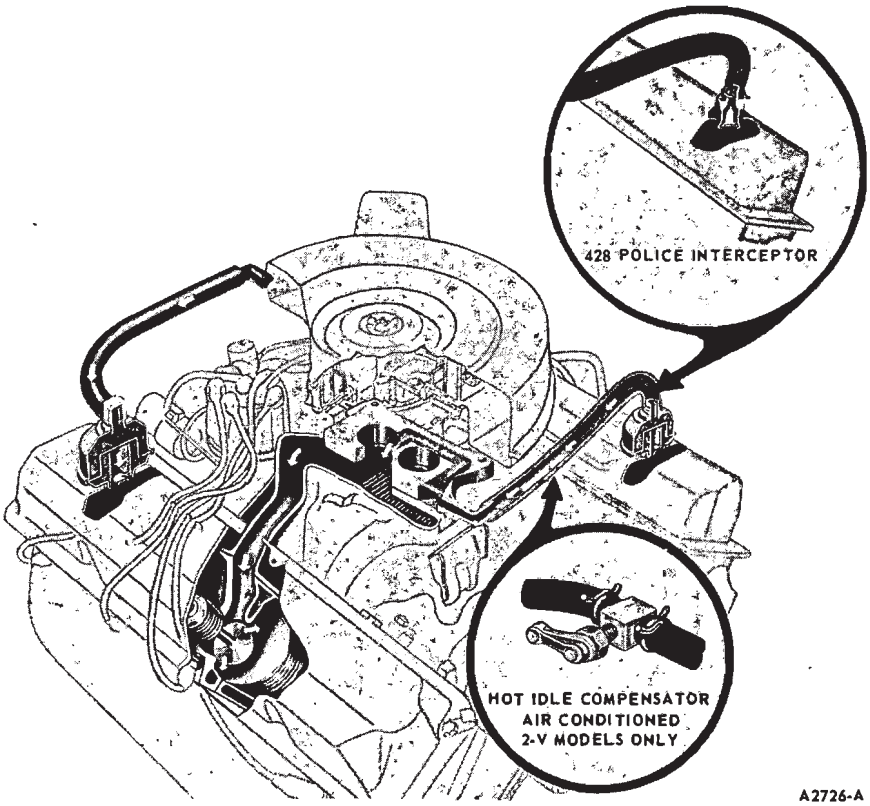

FIG. 12—Positive Closed-Type Crankcase Ventilation System—390 and 428 Engines Except 428 Police Interceptor

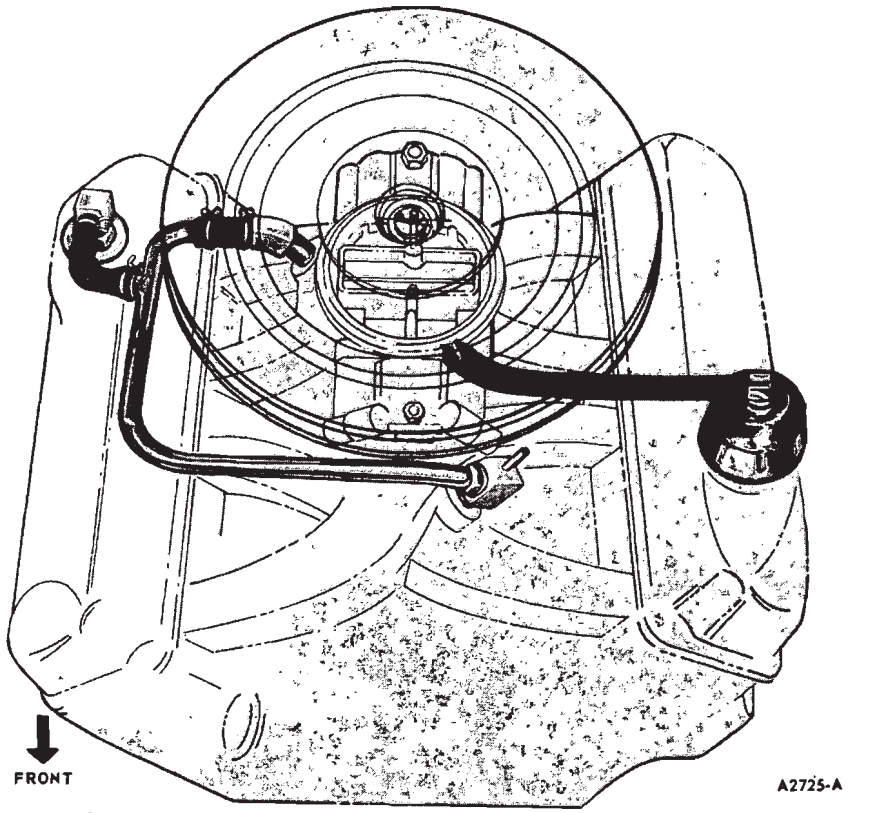

FIG. 13—Positive Closed-Type Crankcase Ventilation System—428 Police Interceptor

tighten all bolts that can be tightened from below. Torque bolts to specifications.

4. If working on a left manifold, install the steering gear to frame and torque bolts to specifications. Install flex coupling to steering shaft.
5. Install right and left insulator to engine and torque bolts to specifications.
6. Install insulators to crossmember and torque bolts to specifications.
7. Install Pitman arm and torque nut to specifications.
8. Install the starter and connect cable.
9. If equipped with power steering, install power cylinder bracket to frame.
10. Install idler arm and torque bolts to specifications.
11. Install clutch linkage and equalizer bracket if equipped with a manual transmission.
12. Install inlet pipes to exhaust manifolds.
13. Install mufflers and hangers.
14. Lower the vehicle.
15. Torque remaining manifold bolts to specifications.
16. Install heat shroud and brackets, 2 manifold studs and nuts.
17. Install carburetor-to-manifold heat tubes.
18. Install air cleaner.
19. Start engine and check for leaks.

POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

REMOVAL

1. Disconnect the vent hose and remove the air cleaner.
2. Remove the vent hose and oil filler cap (Fig. 12 or 13).
3. Disconnect the inlet vent hose from the carburetor spacer or inlet vent tube assembly (428 Police). Grasp the crankcase ventilation regulator valve, and pull it upwards and out of the grommet in the right valve rocker arm cover or oil separator (if so equipped).
4. On 428 Police engines, remove the inlet vent tube assembly from the intake manifold.

INSTALLATION

1. Clean the hoses, inlet vent tube assembly (if so equipped), oil filler cap, oil separator (if so equipped), and carburetor spacer (or intake manifold connections). Follow the clean-

ing procedures in Part 21-01, Section 3. **Do not clean the crankcase ventilation regulator valve. It should be replaced at the interval specified in the maintenance schedule.**

2. On 428 Police engines, install the inlet vent tube assembly on the intake manifold.

3. Install the regulator valve in the vent hose. Connect the vent hose to the carburetor spacer or inlet vent tube tee, and install the regulator valve in the valve rocker arm cover grommet or oil separator (if so equipped). Be sure the grommet is properly seated around the regulator valve.

4. Install the air cleaner, oil filler cap, and vent hose. Connect the vent hose to the air cleaner.

CYLINDER HEADS

REMOVAL

If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts and reface the valves (refer to Part 21-01) before assembling the used parts to the new cylinder head. Check all assembly clearances.

1. On Thermactor engines, disconnect the air lines and hoses as necessary for accessibility. Remove the intake manifold, crankcase ventilation system components, carburetor, and thermostat housing as an assembly following the procedure under Intake Manifold Removal.

2. On all engines disconnect the exhaust manifold(s) at the muffler inlet pipe(s). Leave the manifold(s) attached to the cylinder head(s).

3. If the left cylinder head is to be removed, remove the ignition coil and engine identification tag.

Remove the power steering pump mounting bracket bolts, and position the power steering pump and bracket assembly out of the way. **Leave the fluid lines attached to the power steering pump.**

On a vehicle with air conditioning, remove the compressor mounting bracket bolts and position the compressor out of the way.

4. Remove the cylinder head bolts.

5. Do not pry the cylinder head(s) loose from the cylinder block. Lift the cylinder head(s) off the block. Remove and discard the cylinder head gasket. Remove the baffle plate.

INSTALLATION

1. Clean the cylinder head and cylinder block gasket surfaces.

2. Inspect the cylinder head, following the procedures in Part 21-01, Section 3. **If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces (Part 21-01, Section 3).**

3. All engines use a specially treated composition gasket. **Do not apply sealer to a composition gasket.** Guided by the word FRONT on the gasket, install the gasket over the cylinder head dowels.

4. Place the cylinder head on the engine.

5. Install the cylinder head bolts. The cylinder head bolts are tightened in three progressive steps.

On all engines torque all the bolts in sequence (Fig. 14) to 70 ft-lbs. Then torque them to 80 ft-lbs and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued if desired.

6. On the left cylinder head, install the ignition coil, engine identification tag and power steering pump. Adjust the power steering pump belt tension to specifications.

On a vehicle with an air conditioner, install the compressor mounting bracket with the power steering pump. Adjust the compressor drive belt tension to specifications.

7. Position a new gasket between the muffler inlet pipes and each exhaust manifold, and connect the inlet pipes to the manifolds. Torque the attaching nuts to specifications.

If the left cylinder head was removed, install the ignition coil and the fuel filter (428 Police Interceptor V-8).

8. Install the baffle plate. Install the intake manifold and related parts following the procedure under Intake Manifold Installation. On Thermactor engines connect the hoses.

DISASSEMBLY

1. Remove the Thermactor exhaust emission control system components. Remove the exhaust manifold(s).

2. Taking special care not to damage the exposed machined surfaces, remove the spark plugs. Clean the carbon out of the cylinder head combustion chambers before removing the valves.

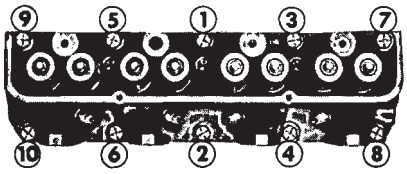

FIG. 14—Cylinder Head Bolt Torque Sequence

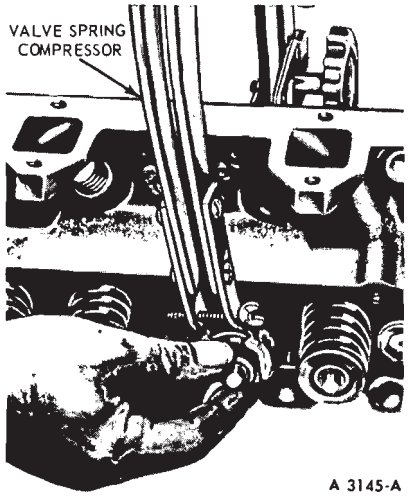

FIG. 15—Compressing Valve Spring-On Bench

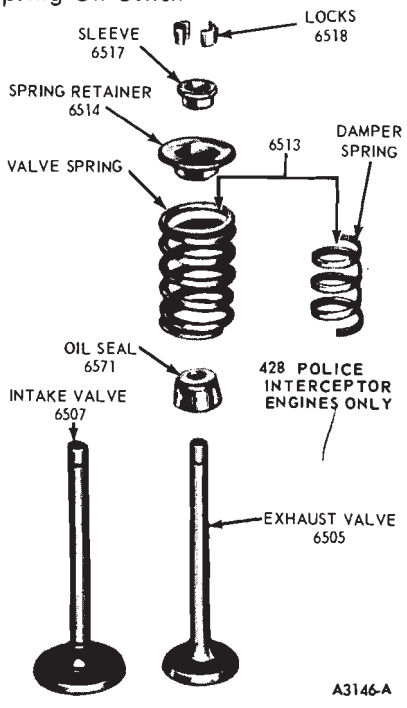

FIG. 16—Typical Valve Assembly

3. Compress the valve springs (Fig. 15). Remove the spring retainer locks and release the spring.

On the 428 Police engines only, in-

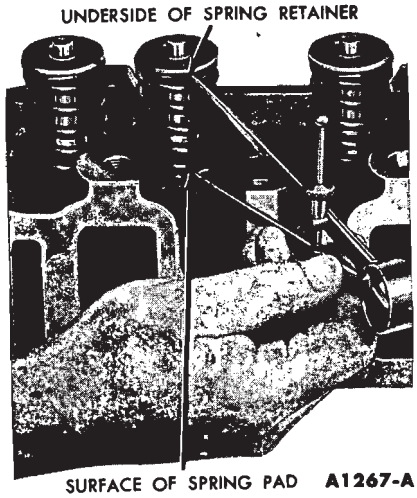

FIG. 17—Valve Spring Assembled Height

spect the valve springs before removal to determine if the damper spring(s) is intertwined with the valve spring(s). If this condition exists, replace all defective or worn components (refer to inspection procedures in Part 21-01, Section 3).

4. Remove the sleeve, spring retainer, spring (and damper spring if applicable), stem seal and valve. Discard the valve stem seals. Identify all valve parts.

Clean, inspect and repair all parts as shown in Part 21-01, Section 2 and 3.

ASSEMBLY

1. Oil each stem with heavy MS oil and install each valve (Fig. 16) in the port from which it was removed or to which it was fitted. Install a new stem seal on the valve. **The exhaust valve stem seal is approximately 0.025 inch shorter in over-all height than the intake valve stem seal (identified with yellow paint); therefore, be sure the seals are installed on the proper valves.**

2. Install the valve spring (closed coils downward) over the valve, and install the spring retainer and sleeve.

On the 428 Police engines only, make sure the damper spring is installed in the valve spring so that the coil end of the damper spring is 135 degrees counterclockwise from the coil end of the valve spring.

3. Compress the spring and install the retainer locks (Fig. 15).

4. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 17). Check the dividers against a scale. If the assembled height is greater than specified, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring (Fig. 18) to bring the assembled height to the recommended specifications.

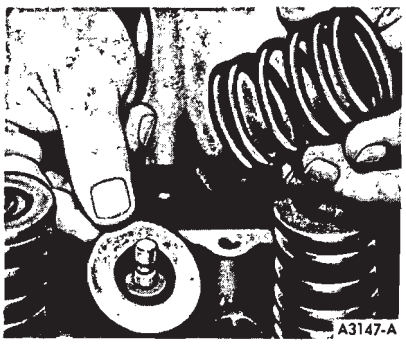

FIG. 18—Installing Valve Spring Spacer

Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.

5. Install the exhaust manifold(s).

6. Install the spark plugs.

7. Install the Thermactor exhaust emission system components.

VALVE SPRING, RETAINER AND STEM SEAL REPLACEMENT

Broken valve springs, or defective valve stem seals and retainers may be replaced without removing the cylinder head provided damage to the valve or valve seat has not occurred.

1. Remove the valve rocker arm cover(s) and rocker arm shaft assembly(ies), following the procedures under Valve Rocker Arm Shaft Assembly Removal.

2. Remove both push rods of the cylinder to be serviced.

3. Tighten the valve rocker arm support bolts evenly and alternately, two turns at a time, until they are snug. Push the rocker arm to one side and secure it in this position (Fig. 19). If an end valve is to be worked on, it will be necessary to remove the rocker arm from the shaft.

4. Remove the applicable spark plug. Install an air adapter in the spark plug hole and connect the air supply hose to the adapter (Fig. 20). Turn on the air supply. **Air pressure may turn the crankshaft until the piston reaches the bottom of its stroke.**

FIG. 19—Compressing Valve Spring-In Chassis

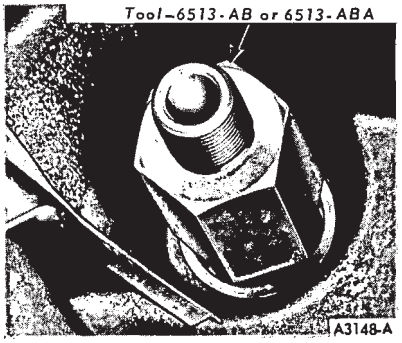

FIG. 20—Installing Air Adapter Tool in Spark Plug Hole

5. Compress the valve spring and remove the valve retainer locks from the valve (Fig. 19).

6. Remove the valve spring and related parts. Remove the valve stem seal (Fig. 21). If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

7. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. **If the valve has been dam-**

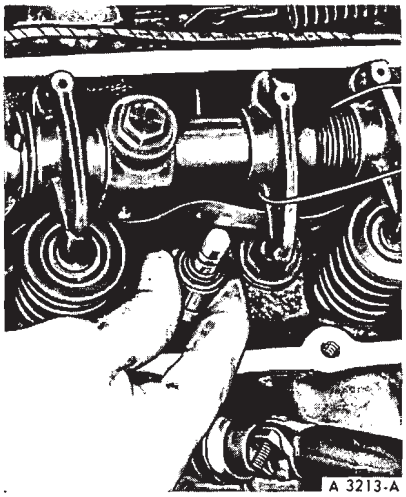

FIG. 21—Removing Valve Stem Seal

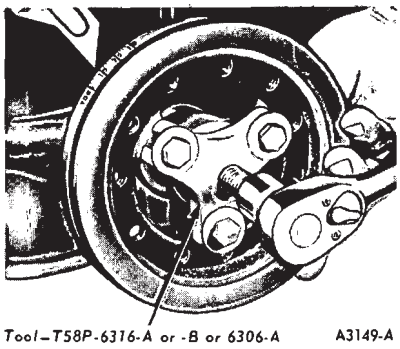

FIG. 22—Removing Crankshaft Damper

aged, it will be necessary to remove the cylinder head for repairs as outlined in Part 21-01, Section 2.

8. If the condition of the valve proved satisfactory, hold the valve in the closed position and apply the air pressure within the cylinder.

9. Inspect the valve stem seal for a cracked, torn or brittle condition, and replace it if necessary. Oil the valve stem with heavy MS oil and install the seal. **The exhaust valve stem seal (identified by yellow paint) is approximately 0.025 inch shorter in overall height than the intake valve stem seal; therefore, be sure the proper seal is installed.**

10. Install the valve springs, retainer and sleeve over the valve stem. **On 428 Police engines only, make sure the valve damper spring is installed in the valve spring so that the coil end of the damper spring is 135 degrees counterclockwise from the coil end of the valve spring.**

11. Compress the valve spring (Fig. 19), and install the valve retainer locks. Tap the valve stem tip with a soft mallet to make certain that the retainer locks are properly seated.

12. Remove the air line and adapter. Install the spark plug. Remove the wire securing the valve rocker arm and slide the rocker arm in position. Install the end rocker arm(s), if they were removed.

13. Crank the engine until No. 1 piston is on TDC at the end of the compression stroke. Rotate the crankshaft damper an additional 45 degrees (identified by XX on the damper).

14. Loosen the valve rocker arm support bolts evenly and alternately two turns at a time, until spring tension is removed. Apply Lubriplate to both ends of the push rod. Position the push rod within the rocker arm socket and the valve lifter seat.

15. Oil the rocker arms and shaft with heavy MS oil. Tighten the rocker arm shaft support bolts evenly and alternately, two turns at a time, until they are snug. Torque the bolts to specifications.

16. Install the spark plug wires. Check the valve clearance and correct if necessary (Part 21-01, Section 2).

17. Clean the valve rocker arm cover(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place on the cover(s).

Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts (and the wire loom clamps on the left cover). The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications. On Thermactor engines, connect the air hoses.

18. Connect the automatic choke heat chamber air inlet tube. Install the air cleaner.

WATER PUMP

REMOVAL

1. Drain the cooling system. Remove the bolts and nuts attaching the power steering pump mounting bracket. Remove the power steering pump and mounting bracket as an assembly, and position it to one side.

2. Remove the power steering, air conditioning, and Thermactor drive belts, if so equipped.

3. Disconnect the radiator lower hose and heater hose at the water pump. Remove the radiator upper support and fan guard. Remove the fan belt(s), fan, fan spacer or fan drive clutch and pulley.

4. Remove the four bolts attaching the pump to the block. Remove the pump and gaskets.

INSTALLATION

Before a water pump is re-installed, check it for damage. If it is damaged and requires repair, replace it with a new pump.

1. If a new water pump is to be installed, remove the heater hose fitting from the old pump and install it on the new pump. Remove all gasket material from the mounting surfaces of the cylinder front cover or block and water pump.

2. Position a new gasket, coated on both sides with sealer, on the cylinder block; then install the pump.

3. Install the attaching bolts and torque them to specifications.

Install the power steering pump and bracket assembly. Install the power steering, air conditioning, and Thermactor drive belts, if so equipped.

4. Install the pulley, spacer or fan drive clutch and fan. Torque the capscrews evenly and alternately to specifications. Then, check the fan drive clutch flange-to-water pump hub (if so equipped) for proper mating. Install the belt(s) and adjust the belt tension to specifications. Connect the radiator hose and heater hose. Install the radiator upper support and fan guard.

5. Fill and bleed the cooling system. Operate the engine until normal operating temperatures are reached and check for leaks.

CYLINDER FRONT COVER AND TIMING CHAIN

If the cylinder front cover is being removed to replace the gasket or to replace the fuel pump drive eccentric, it is not necessary to check the timing chain deflection. For cylinder front cover gasket replacement, it it not necessary to remove the timing chain and sprockets.

REMOVAL

1. Drain the cooling system and the crankcase. Disconnect the battery ground cable.

2. Disconnect the radiator upper hose at the thermostat housing. Disconnect the radiator lower hose at the water pump. On a vehicle with automatic transmission, disconnect the transmission oil cooler lines from the

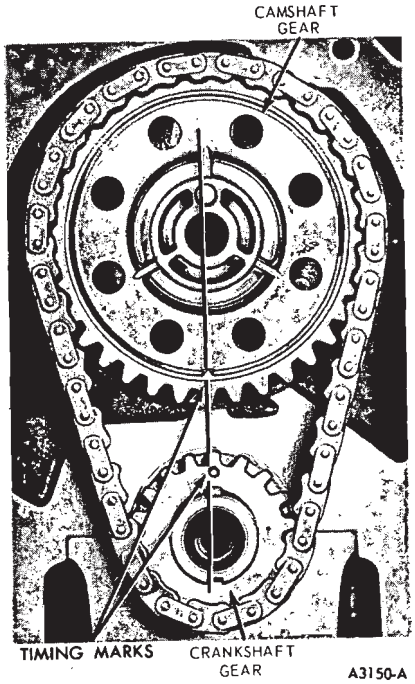

FIG. 23—Aligning Timing Marks

radiator.

3. Remove the radiator.

4. Disconnect the heater hose at the water pump and remove the hose from the choke housing clamp. Slide the water pump bypass hose clamp toward the engine.

On a vehicle with power steering, remove the power steering pump bracket mounting bolts. Position the pump assembly to the left side of the vehicle in a position that will prevent the fluid oil from draining out.

On a vehicle with an air conditioner, remove the compressor mounting bracket bolts, and position the compressor out of the way. **Do not disconnect the compressor refrigerant lines.**

5. Loosen the alternator mounting bolts at the alternator. Remove the drive belt. Remove the alternator support bracket bolts at the water pump and move the brackets out of the way. Remove the water pump and fan assembly.

On a vehicle with air conditioning remove the condenser attaching bolts and position the condenser forward. **Do not disconnect the refrigerant lines.** Remove the compressor drive belt. On Thermactor engines remove the air supply pump drive belt. If so equipped, remove the accessory drive pulley.

6. Remove the cap screw and washer from the end of the crankshaft. On a vehicle with power steering remove the power steering pulley from the crankshaft damper. Install the puller on the crankshaft damper (Fig. 22) and remove the damper.

7. Disconnect the carburetor fuel inlet line at the fuel pump.

8. Remove the fuel pump attaching bolts and lay the pump to one side with the flexible fuel line still attached.

9. Remove the crankshaft sleeve.

10. Remove the screws fastening the cylinder front cover to the block and to the oil pan. Using a thin blade knife cut the oil pan gasket flush with cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover.

11. Discard the cylinder front cover gasket. Remove the crankshaft front oil slinger.

12. Crank the engine until the timing marks on the sprockets are positioned as shown in Fig. 23.

13. Remove the camshaft sprocket cap screw and the fuel pump eccentric.

14. Slide both sprockets and the timing chain forward, and remove them as an assembly (Fig. 24).

FIG. 24—Removing or Installing Timing Chain and Sprocket

FRONT OIL SEAL REPLACEMENT

It is good practice to replace the oil seal each time the cylinder front cover is removed.

1. Drive out the old seal with a pin punch. Clean out the recess in the cover.

2. Coat a new seal with grease, and install the seal. Drive the seal in until it is fully seated in the recess (Fig. 25). Check the seal after installation to be sure the spring is properly positioned in the seal.

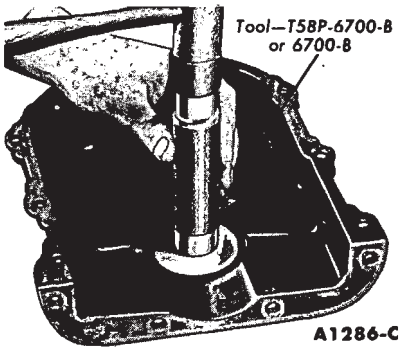

FIG. 25—Installing Oil Seal

INSTALLATION

1. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24). Be sure the timing marks on the sprockets are positioned as shown in Fig. 23.

2. Install the fuel pump eccentric and the cam shaft sprocket cap screw to specifications. Install the crankshaft front oil slinger.

3. Clean all oil pan and cylinder block to front cover gasket surfaces.

4. Coat the gasket surface of the oil pan with sealer, cut and position the required section of a new gasket on the oil pan; apply sealer at the corners.

5. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

6. Position the cylinder front cover on the cylinder block. **Use care when installing the cover to avoid seal damage or possible gasket mislocation.**

7. Install the cylinder front cover to seal alignment tool into proper position. It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the cover attaching screw hole locations in the cylinder block.

8. Coat the threads of the attaching bolts with oil-resistant sealer.

While pushing in on the pilot, install and torque the oil pan to cover attaching screws to specifications. Install and torque the oil pan to cover attaching screws to specifications. Install and torque the cover attaching screws to specification (Fig. 27). Remove the pilot.

9. Lubricate the front seal contact surface of the sleeve with lubriplate and install the crankshaft sleeve.

10. Lubricate the inside diameter of the hub and line up the damper keyway with the key on the crankshaft. Install the damper on the

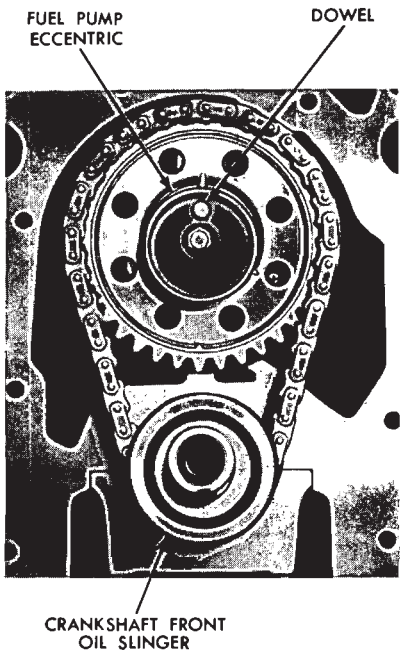

FIG. 26—Fuel Pump Eccentric and Front Oil Slinger Installed

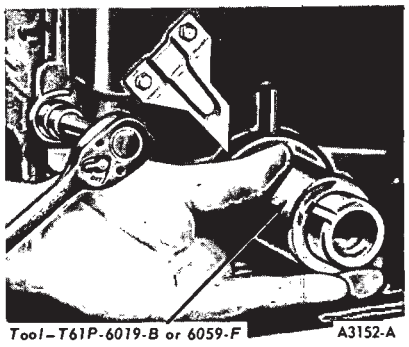

FIG. 27—Aligning Cylinder Front Cover

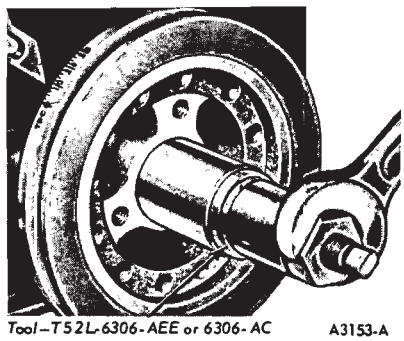

FIG. 28—Installing Crankshaft Damper

crankshaft (Fig. 28).

11. On a vehicle with power steering, install the power steering pump pulley on the damper. Torque the screws to specifications. Install the damper cap screw and washer. Torque the screw to specifications.

12. Clean the water pump gasket surfaces. Coat new gaskets with water-resistant sealer and position the gaskets on the block. Install the water pump and fan, and torque the water pump mounting bolts to specifications. Attach the alternator adjusting arm and mounting bracket to the water pump.

13. Install and adjust the alternator drive belt(s) to the specified tension.

14. Install the fuel pump, using a new gasket. Connect the carburetor fuel inlet line, to the fuel pump and to the carburetor filter. Use new clamps.

15. On a vehicle with an air conditioner, install the compressor and adjust the drive belt. On Thermactor engines, install the air pump drive belt and adjust to specifications.

On a vehicle with power steering, install the power steering pump and drive belt. Adjust the drive belt tension to specification.

16. Connect the heater hoses. Slide the water pump bypass tube clamp forward on the tube.

17. Install the radiator. Connect the radiator lower hose at the water pump and the radiator upper hose at the thermostat housing. Connect the battery ground cable.

On a vehicle with an automatic transmission, connect the transmission oil cooler lines.

18. If any of the coolant entered the oil pan when separating the cylinder front cover from the block, the crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.

19. Fill and bleed the cooling system. Connect the heater hose to the intake manifold.

20. Operate the engine at fast idle and check for coolant and oil leaks. Adjust the ignition timing.

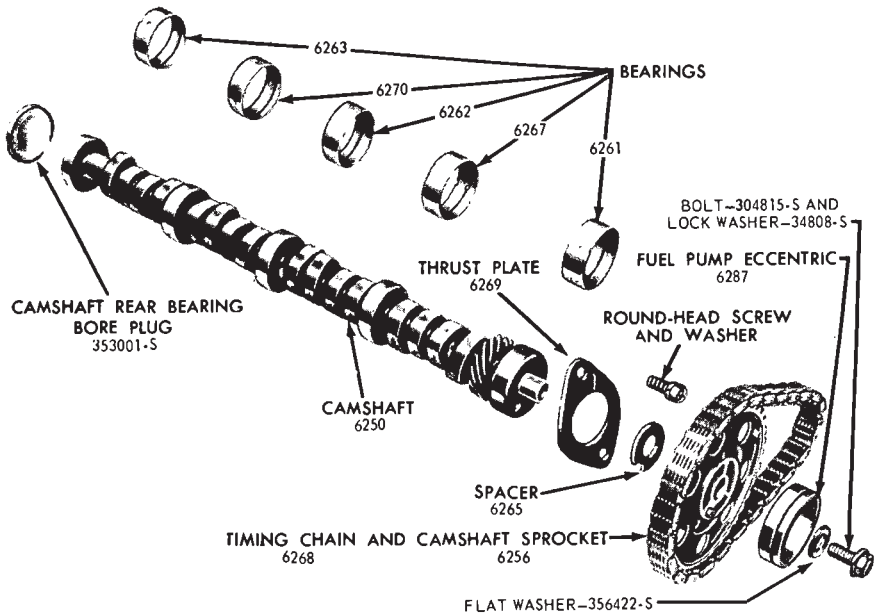

FIG. 29—Camshaft and Related Parts

CAMSHAFT

The camshaft and related parts are shown in Fig. 29.

REMOVAL

1. Remove the cylinder front cover and the timing chain and sprockets following steps 1 thru 11 under Cylinder Front Cover and Timing Chain Removal. On Thermactor engines, disconnect the air hoses as necessary for accessibility, and position them out of the way.

2. Remove the grille. On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side. **Do not disconnect the condenser refrigerant lines.**

3. Refer to Valve Rocker Arm Shaft Assembly Removal, and remove the valve rocker arm covers and the valve rocker arm shaft assemblies.

4. Remove the intake manifold and

baffle plate, following the procedures under Intake Manifold Removal.

5. Remove the valve lifters and place them in a rack so they can be identified and installed in their original locations.

6. Remove the timing chain and sprockets following steps 12 thru 14 under Cylinder Front Cover and Timing Chain Removal.

7. Remove the camshaft thrust plate and spacer. Carefully remove the camshaft by pulling it toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**

INSTALLATION

1. Oil the camshaft journals with heavy MS oil and apply Lubriplate to the lobes. Carefully slide the camshaft through the bearings. Install the thrust plate and spacer. **The chamfered ID of the spacer must be toward the camshaft front journals. Be sure the thrust plate oil groove is up and towards the front (next to camshaft sprocket).**

2. Check the camshaft end play. Install a dial indicator so the indicator point is on the camshaft sprocket attaching screw. Push the camshaft toward the rear of the engine and set the dial indicator on zero. Pull the camshaft forward and release it. Compare the indicator reading with the specifications. If the end play is excessive, check the spacer for correct installation. If the spacer is installed correctly, replace the thrust plate.

3. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24) with the timing marks on the sprockets aligned as shown in Fig. 23.

4. Install the fuel pump eccentric and the camshaft sprocket cap screw (Fig. 26). Torque the sprocket cap screw to specifications. Install the front oil slinger.

5. Replace the crankshaft front oil seal. Install the cylinder front cover, crankshaft damper, and related parts following steps 3 thru 14 under Cylinder Front Cover and Timing Chain Installation.

6. Install the grille.

7. Install the valve lifters in the bores from which they were removed. Install the intake manifold, following the procedures under Intake Manifold Installation.

8. Install the push rods in their original positions. Refer to Valve Rocker Arm Shaft Assembly Installation, and install the valve rocker arm shaft assembly following steps 1 thru 8.

On Thermactor engines connect the air hoses.

On a vehicle with air conditioning, position the condenser and install the attaching bolts. Install the radiator.

9. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

10. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

CAMSHAFT REAR BEARING BORE PLUG REPLACEMENT

1. On a vehicle with a manual-shift transmission, slide the transmission to the rear and remove the clutch pressure plate, disc and flywheel housing following the procedure in Group 16.

On a vehicle with an automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

2. Remove the flywheel attaching bolts and remove the flywheel. Remove the rear cover plate.

3. Replace the core plug as detailed in Part 21-01, Section 2.

4. Install the rear cover plate. Install the flywheel.

On a vehicle with a manual-shift transmission, install the clutch pressure plate disc, flywheel housing and transmission following the procedure in Group 16.

On a vehicle with an automatic transmission, install the transmission and converter housing following the procedure in Group 17.

HYDRAULIC VALVE LIFTER REPLACEMENT

The following procedure is applicable for removing one or all of the valve lifters. Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improper valve clearance or by worn rocker arms or push rods.

1. Refer to Valve Rocker Arm Shaft Assembly Removal, and remove the valve rocker arm covers and valve rocker arm shaft assemblies following steps 1 thru 5.

2. Position an inspection light to shine through the push rod opening and into the push rod valley (Fig. 30). Remove the lifters with a claw-type tool through the push rod openings. In some cases it will be necessary to transfer the lifter to an adjoining opening in order to remove it. Place the lifters in a rack so that they can be installed in their original positions.

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not inter-mix the parts. Keep the assemblies intact until they are to be cleaned.

3. Install the new (or cleaned) hydraulic valve lifters through the push

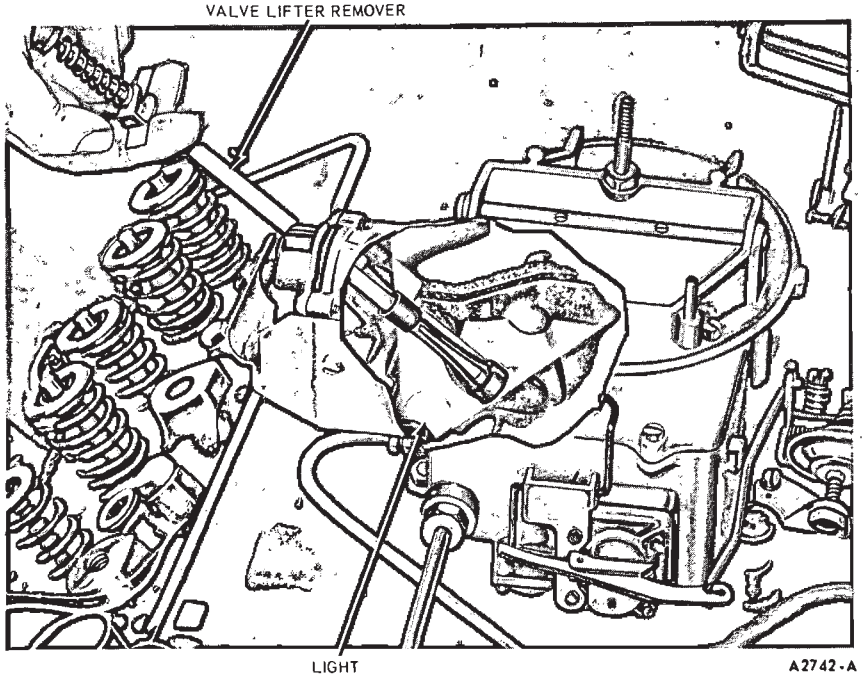

FIG. 30—Removing or Installing Valve Lifter Intake Manifold Installed

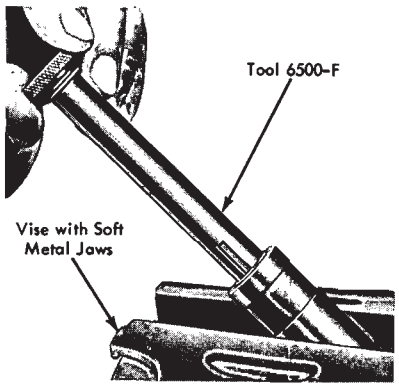

FIG. 31—Removing Lifter Plunger

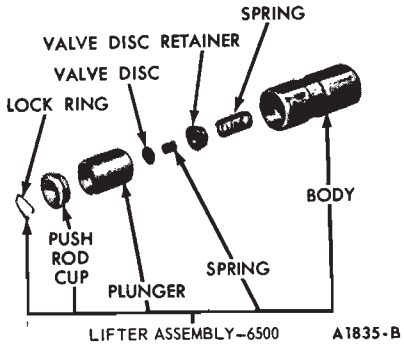

FIG. 32—Typical Hydraulic Valve Lifter Assembly

rod openings with the lifter removal tool (Fig. 30). Install the push rods in their original positions.

4. Refer to Valve Rocker Arm Shaft Assembly Installation and install the valve rocker arm shaft assemblies and rocker arm covers by following steps 4 thru 8.

HYDRAULIC VALVE LIFTER DISASSEMBLY

Each valve lifter is a matched assembly. If the parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so that they can be installed in their original bores.

1. Grasp the lock ring with the needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.

2. Remove the push rod cup. Remove the plunger (Fig. 31) and plunger spring.

3. Invert the plunger assembly and remove the disc valve retainer by carefully prying up on it with a screwdriver. Remove the disc valve and spring.

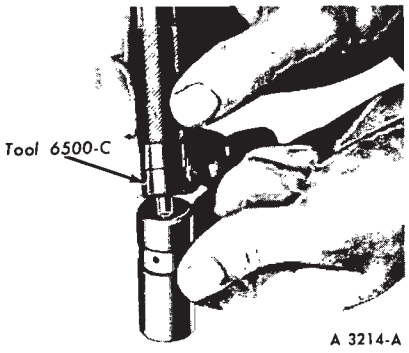

FIG. 33—Installing Valve Lifter Lock Ring

HYDRAULIC VALVE LIFTER ASSEMBLY

A typical hydraulic valve lifter assembly is shown in Fig. 32.

1. Place the plunger upside down on a clean work bench.

2. Place the disc valve in position over the oil hole on the bottom of the plunger. Set the disc valve spring on top of the disc.

3. Position the disc valve retainer over the disc and spring and push the retainer down into place on the plunger.

4. Place the plunger spring and then the plunger (open end up) into the lifter body.

5. Place the push rod cup in the plunger.

6. Push the plunger and push rod cup into the body and install the lock ring (Fig. 33). Release the plunger; then depress it again to fully seat the lock ring.

7. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

VALVE CLEARANCE—HYDRAULIC VALVE LIFTERS

The valve arrangement is E-I-E-I-I-E-I-E from front to rear on both cylinder banks.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. **Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay.** Install an auxiliary starter switch between the battery and S terminals of the Starter relay. **Crank the engine with the ignitions switch OFF until the No. 1 piston is on TDC after the compression stroke.**

2. With the crankshaft in the positions designated in Steps 3 and 4, position the hydraulic lifter compressor tool (T58P-6565-A) on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed. Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install an under size push rod. If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke, check the following valves:

No. 1 Intake No. 1 Exhaust
No. 3 Intake No. 4 Exhaust
No. 7 Intake No. 5 Exhaust
No. 8 Intake No. 8 Exhaust

4. After these valves have been checked, rotate the crankshaft 360 degrees (one revolution) to position No. 6 piston on TDC and check the following valves:

No. 2 Intake No. 2 Exhaust
No. 4 Intake No. 3 Exhaust
No. 5 Intake No. 6 Exhaust
No. 6 Intake No. 7 Exhaust

5. When compressing the valve spring to remove the push rods, be sure the piston in the individual cylinder is below TDC to avoid contact between the valve and the piston.

To replace a push rod, it will be necessary to remove the valve rocker arm shaft assembly, following the procedure in Parts 21-03 and 06.

Upon replacement of a valve push rod, valve rocker arm shaft assembly or hydraulic valve lifter, the engine should not be cranked or rotated until the hydraulic lifters have had an op-

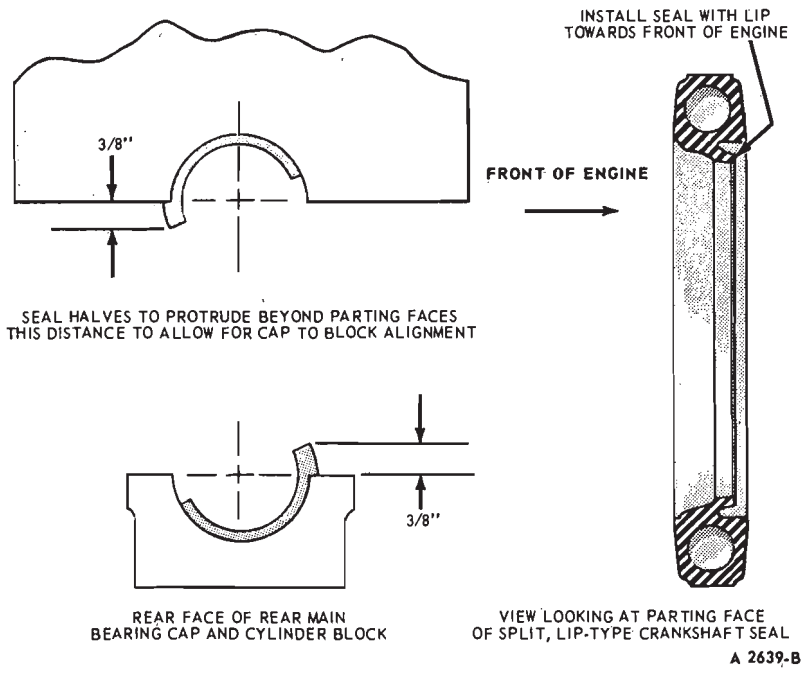

FIG. 34—Installing Crankshaft Rear Seal

portunity to leak down to their normal operating position. The leak-down rate can be accelerated by using the compressor tool (T58P-6565-A) on the valve rocker arm and applying pressure in a direction to collapse the lifter.

CRANKSHAFT REAR OIL SEAL REPLACEMENT—SPLIT LIP TYPE

Replacement of a crankshaft rear oil seal to correct for oil leaks requires replacement of both the upper and lower seals, as follows:

1. Remove the oil pan and oil pump (as required) following the procedures in this section.
2. Loosen all the main bearing cap bolts, thereby lowering the crankshaft slightly but not to exceed 1/32 inch.
3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal use a seal removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. **Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.**
4. Carefully clean the seal grooves in the cap and block with a brush and solvent.
5. Dip the split, lip-type seal halves in clean engine oil.
6. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34), by rotating it on the seal journal of the crankshaft until approximately 3/8 inch protrudes below the parting surface.

Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.

7. Tighten the remaining bearing cap bolts and torque to specifications.
8. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 34), allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed.
9. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.
10. Dip the side seals in light engine oil; then immediately install them in the grooves. Do not use sealer on the side seals. **The seals are designed to expand when dipped in oil. Using sealer may retard this expansion.** It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.
11. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**
12. Install the oil pump and oil pan. Install the oil level dipstick. Fill the crankcase with the proper amount and viscosity oil.
13. Operate the engine and check for oil leaks.

MAIN AND CONNECTING ROD BEARING REPLACEMENT

The main and connecting rod bearing inserts are selective fit. **Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.**

Selective fit bearings are available for service in standard size 0.001 and 0.002 inch undersize. A standard bearing may be used in the cylinder block with a 0.001 or 0.002 inch bearing in the bearing cap to reduce or obtain the proper clearance. Refer to the Parts Catalog for the available sizes. Undersize bearings, which are not selective fit, are available for use on journals that have been refinished.

MAIN BEARING REPLACEMENT

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and oil pump. Remove the spark plugs to allow easy rotation of the crankshaft.
2. **Replace one bearing at a time, leaving the other bearing securely fastened.** Remove the main bearing cap to which new bearings are to be installed.
3. Insert the upper bearing removal tool (tool 6331-E) in the oil hole in the crankshaft (Fig. 35).
4. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
5. Clean the crankshaft journal and bearing inserts. **When replacing standard bearings with new bearings, it is good practice to try to obtain the proper clearances with a standard and 0.001 or 0.002 inch undersize bearing halves.**
6. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331-E can be inserted in the oil hole in the crankshaft

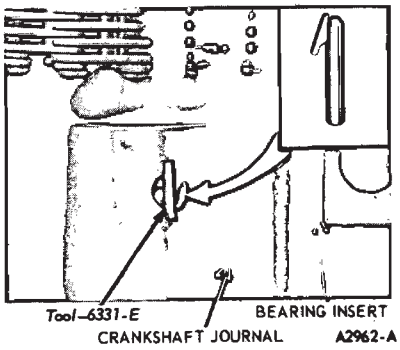

FIG. 35—Removing or Installing Upper Main Bearing Insert

(Fig. 35). With tool 6331-E positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

7. Install the lower bearing in the cap. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

8. If Plastigage indicates the clearance is less than the specified limits, try a combination of standard and undersize bearings. If the clearance exceeds specified service limits, try 0.002 inch undersize bearings in combination with a standard bearing. The bearing clearance must be within specified service limits. Whenever a combination of undersize bearings with standard bearings is used, the undersize bearing should go in the top, or block. If the standard and 0.002 inch undersize bearings do not bring the clearance within the desired limits, refinish the crankshaft journal (Refer to Part 21-01, Section 02). Then install undersize bearings.

9. After the bearing has been checked and found to be satisfactory, apply a light coat of heavy MS engine oil to the journal and bearings; then install the bearing cap. Torque the cap bolts to specifications.

10. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.

11. Repeat the procedure for the remaining bearings that require replacement.

12. If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear seal and side seals.

13. Clean the rear journal oil seal grooves in the block and cap.

14. Install a new rear oil seal in the rear main bearing cap and block, following the procedures under Crankshaft Rear Oil Seal Replacement.

15. Apply a thin coating of oil resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.

16. Dip the side seals in light engine oil; then immediately install them in the grooves. **Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion.** It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

17. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**

18. Disassemble, clean and assemble the oil pump if necessary (Refer to Part 21-01, Section 3). Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and oil pan.

19. Install the oil level dipstick. Fill the crankcase with the proper amount and viscosity oil. Install the spark plugs.

20. Operate the engine and check for oil leaks.

CONNECTING ROD BEARING REPLACEMENT

1. Follow step 1 under Main Bearing Replacement.

2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down.

3. Remove the connecting rod cap. Push the connecting rod up into the cylinder and remove the bearing insert from the rod and cap.

4. Follow step 5 under Main Bearing Replacement.

5. Install the new bearings in the connecting rod and cap. Pull the connecting rod assembly down firmly on the crankshaft journal. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. If the clearance is less than the specified limits, try an undersize bearing half in combination with a standard bearing half.

The bearing clearance must be within specified service limits.

If the proper clearance cannot be achieved with a standard in combination with an 0.002 undersize bearing, the crankshaft will have to be ground undersize and fitted with undersize bearings (Refer to Part 21-01, Section 2).

7. After the bearing clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap.

8. Repeat the procedure for the remaining connecting rods that require new bearings.

9. Follow step 21, 22 and 23 under Main Bearing Replacement.

PISTON AND CONNECTING ROD ASSEMBLY

REMOVAL

1. Drain the cooling system and the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump following the procedures in this section.

2. Remove any ridge and/or deposits from the upper end of the cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the top of piston to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter (tool 6011-E). Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all connecting rod caps are marked so that they can be installed in their original locations.

4. Turn the crankshaft until the connecting rod being removed is down.

5. Remove the connecting rod cap.

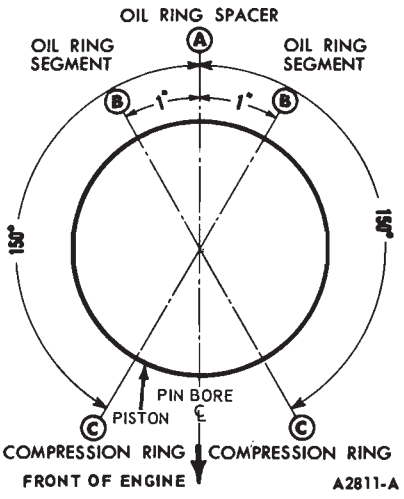

FIG. 36—Piston Ring Gap Spacing

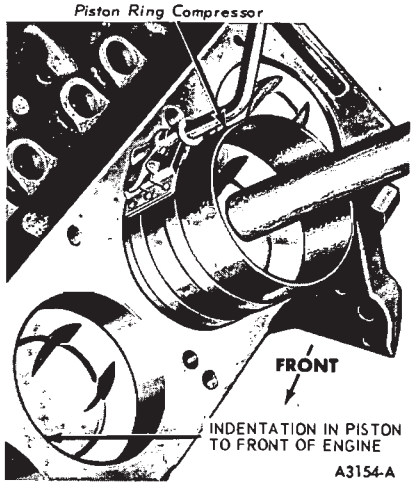

FIG. 37—Typical Piston Installation

6. Push the connecting rod and piston assembly out of the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**

7. Remove the bearing inserts from the connecting rod and cap.

8. Install the cap on the connecting rod from which it was removed.

INSTALLATION

1. If new piston rings are to be installed, remove the cylinder wall glaze (Part 21-01, Section 2, Repairs-Cylinder Block). Follow the instructions of the tool manufacturer. After performing cylinder bore repairs, clean the bore(s), following the procedure in Part 21-01, Section 3.

2. Oil the piston rings, pistons and cylinder walls with light engine oil. **Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing cap are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**

3. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 36).

4. Oil the piston rings generously. Then install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 37). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. **Install the piston with the indentation in the piston head toward the front of the engine.**

5. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.

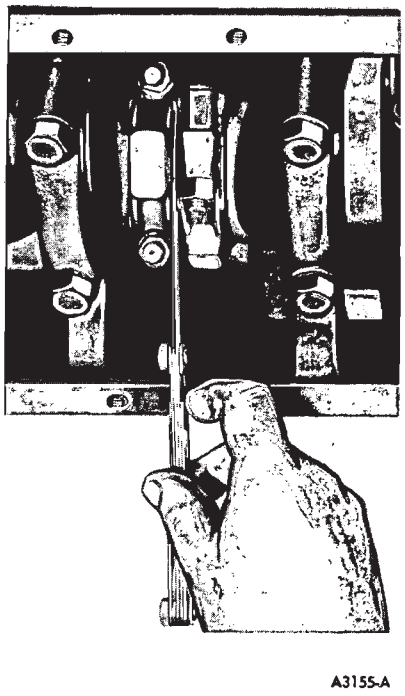

FIG. 38—Checking Connecting Rod Side Clearance

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

8. Install the connecting rod cap. Torque the nuts to specifications.

9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal (Fig. 38).

10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and cylinder block gasket surfaces.

11. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and pan.

12. Install the cylinder heads by following step 1 thru 6 under Cylinder Head Installation.

13. Refer to Intake Manifold Installation and install the intake manifold by following steps 2 thru 18.

14. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

15. Install the automatic choke heat chamber air inlet tube. Install the air cleaner. Operate the engine and check for oil and coolant leaks. Check and adjust the ignition timing.

16. Adjust the engine idle speed and fuel mixture. Refer to Part 23-01, Section 2.

DISASSEMBLY

1. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.

2. Remove the piston rings. Remove the piston pin retainers. Drive the pin out of the piston and connecting rod (Fig. 39). Discard the retainers.

ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 40.

1. Lubricate all parts with light engine oil. Position the connecting rod in the piston and push the pin into place. Assemble the piston and connecting rod as shown in Fig. 41.

2. Insert new piston pin retainers

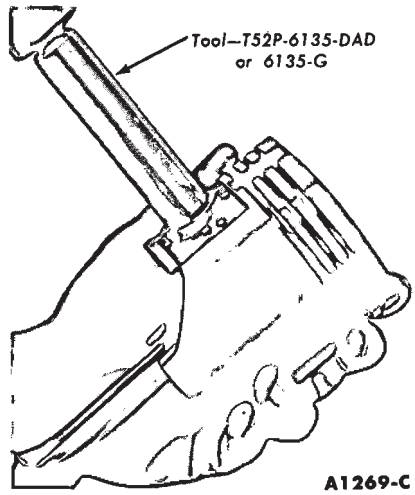

FIG. 39—Removing Piston Pin

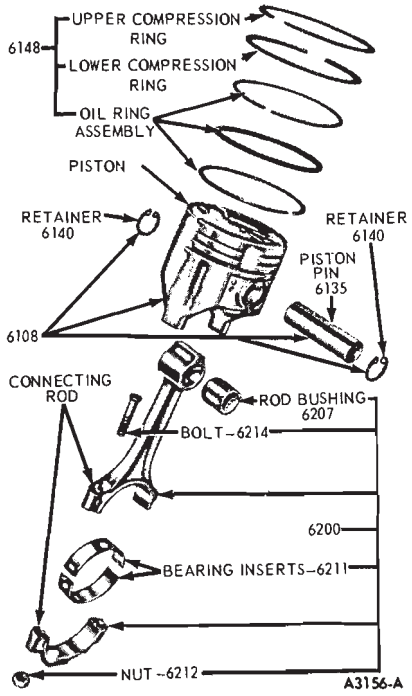

FIG. 40—Piston, Connecting Rod and Related Parts

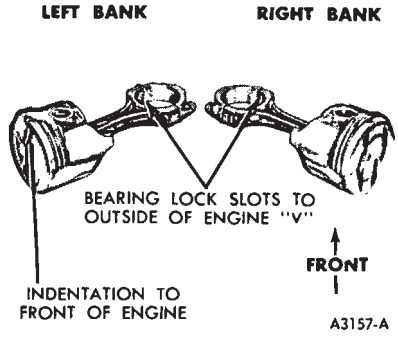

FIG. 41—Correct Piston and Connecting Rod Position

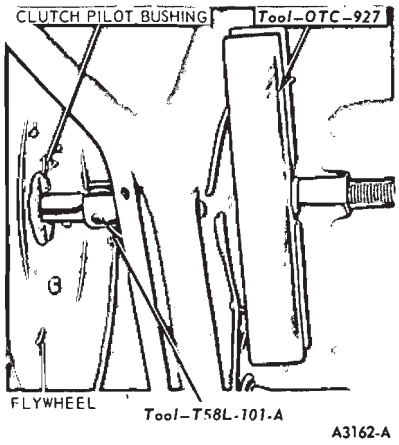

FIG. 42—Removing Clutch Pilot Bushing

into the piston. Check the end gap of all piston rings (Part 21-01). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings. Be sure the piston ring gaps are properly spaced (Fig. 36).

3. Check the ring side clearance of the compression rings with a feeler gauge (Refer to Fitting Piston Rings in Part 21-01, Section 2).

4. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

FLYWHEEL

REMOVAL

1. Disconnect the transmission from the engine and slide it to the rear as outlined in Group 16 (manual-shift transmission), or on an automatic transmission remove the transmission (Group 17).

On a manual-shift transmission, remove the pressure plate and cover assembly as outlined in Group 16.

2. Remove the flywheel attaching bolts and remove the flywheel.

INSTALLATION

1. Install the flywheel on the crankshaft flange and install the attaching bolts. Torque the bolts to specifications, in sequence (across from each other).

2. Check the flywheel runout, following the procedure in Part 21-01, Section 1.

3. On a manual-shift transmission, install the pressure plate and cover assembly (Group 16).

4. Connect the transmission to the engine as outlined in Group 16 (manual-shift transmissions), or on an automatic transmission, install the transmission Group 17). It is not necessary to adjust the transmission, when it has been removed only for flywheel removal.

CLUTCH PILOT BUSHING REPLACEMENT

Inspection procedures are outlined under Crankshaft Cleaning and Inspection in Part 21-01, Section 3.

1. Disconnect the transmission from the engine and slide it to the rear as outlined in Group 16.

2. Remove the pressure plate and cover assembly and the clutch disc as outlined in Group 16.

3. Remove the pilot bushing (Fig. 42).

4. Coat the pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. **Avoid using too much lubricant as it may be thrown onto the clutch disc when the clutch revolves.**

5. Install the pilot service bearing (Fig. 43).

6. Install the clutch disc and the pressure plate and cover assembly as outlined in Group 16.

7. Connect the transmission to the engine as outlined in Group 16.

OIL FILTER REPLACEMENT

The Autolite oil filter assembly is shown in Fig. 44.

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting. Clean the adapter filter recess.

2. Coat the gasket on the new filter with oil. Place the filter in position on the adapter (Fig. 45). Hand tighten the filter until the gasket contacts the adapter face. Then advance it 1/2 turn.

3. Operate the engine at fast idle and check for leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

OIL PAN

REMOVAL

1. Raise the vehicle and place safety stands into position. Drain the oil

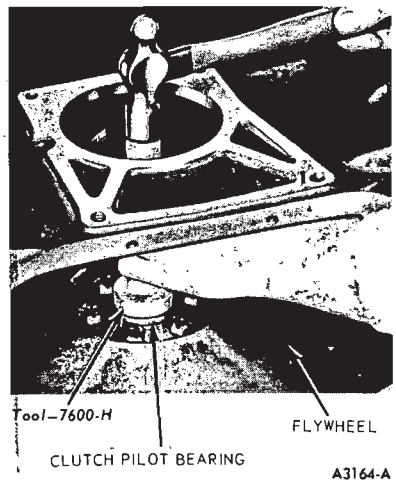

FIG. 43—Installing Clutch Pilot Bearing

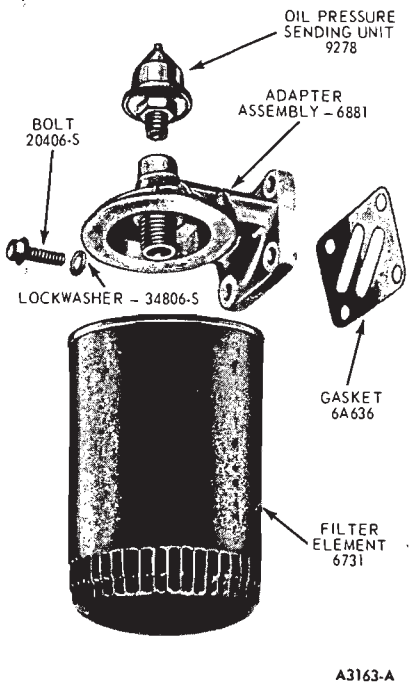

FIG. 44—Oil Filter Assembly

from the crankcase. On a vehicle equipped with air conditioning, remove the fan shroud from the radiator and position it over the fan.

2. Disconnect the stabilizer bar at the connecting links and pull the ends down.

3. To allow clearance for removal of the oil pan, remove the engine front support insulator to intermediate support bracket nuts and lock washers. Install a block of wood on a floor jack and position the jack under the front leading edge of the oil pan. Raise the engine approximately 1-1/4 inches and insert a 1 inch block of wood between the insulators and the

FIG. 45—Replacing Oil Filter

frame cross-member. Remove the floor jack.

4. Remove the oil pan attaching screws and lower the oil pan to the frame cross member.

5. Crank the engine to obtain the necessary clearance between the crankshaft counterweight and the rear of the oil pan. Remove the upper bolt and loosen the lower bolt on the inlet tube (Fig. 46). Position the inlet tube and screen out of the way, and remove the oil pan.

INSTALLATION

1. Clean the oil pan and cylinder block gasket surfaces following the procedures in Part 21-01. Clean the oil pump inlet tube screen. Position a new oil pump inlet tube gasket on the oil pump and install the inlet tube (Fig. 46) with the lower bolt only. Do not tighten the bolt.

2. Apply oil-resistant sealer to the oil pan gasket surfaces and position the gasket on the oil pan.

3. Position the oil pan on the crossmember and install the inlet tube to oil pump upper mounting bolt. Tighten both bolts.

4. Hold the oil pan in place against the cylinder block and install an attaching screw on each side of the pan. Using the special spring washers, install the oil pan to rear main bearing cap bolts. Install the remaining screws and tighten them from the center outward. Torque the screws to

FIG. 46—Oil Pump and Inlet Tube Installed

specifications.

5. Position the floor jack and block of wood under the leading edge of the oil pan. Raise the engine slightly and remove the wood blocks from beneath the insulators. Lower the engine and remove the jack. Install the insulator to frame lock washers and nuts. Torque the nuts to specifications.

6. Connect the stabilizer bar. **Replace the oil filter.** Remove the safety stands and lower the vehicle. If the fan shroud was removed, install it on the radiator.

7. Fill the crankcase with the proper grade and quantity of engine oil. Operate the engine and check for oil leaks.

OIL PUMP

REMOVAL

1. Remove the oil pan (refer to Oil Pan Removal).

2. Remove the oil pump attaching screws; then remove the oil pump and intermediate drive shaft.

3. Remove the inlet tube and screen assembly from the oil pump. Discard the gasket.

INSTALLATION

1. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

2. Position a new gasket on the pump housing. Insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly (Fig. 46). **Do not attempt to force the pump into position if it will not seat**

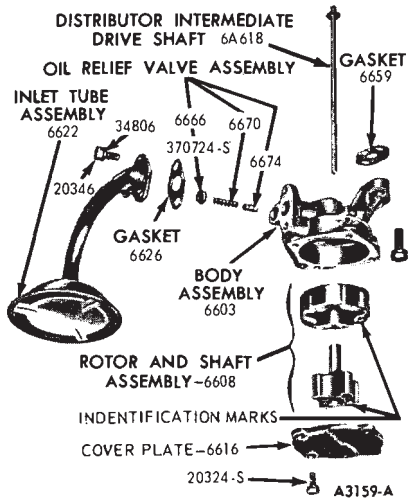

FIG. 47—Oil Pump Disassembled

readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate shaft into a new position. Torque the oil pump attaching screws to specifications.

3. Install the inlet tube and screen assembly and oil pan, following the procedure under Oil Pan Installation.

DISASSEMBLY

1. Remove the oil inlet tube from the oil pump and remove the gasket.
2. Remove the cover attaching screws, then remove the cover. Remove the inner rotor and shaft assembly and the outer race.
3. Remove the staking marks at the relief valve chamber cap. Insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

ASSEMBLY

The oil pump assembly is shown in Fig. 47.

1. Oil all parts thoroughly.
2. Install the oil pressure relief valve plunger, spring and a new cap. Stake the cap.
3. Install the outer race and the inner rotor and shaft assembly. **Be sure the dimple (identification mark) on the outer race is facing outward and on same side as identification mark on rotor. The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.** Install the cover. Torque the cover attaching screws to specifications.
4. Position a new gasket and the oil inlet tube on the oil pump and install the attaching bolts.

3 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached.

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REMOVAL

1. Drain the cooling system and the crankcase. Remove the hood. Remove the air cleaner and disconnect the battery positive cable.
2. Disconnect the radiator upper hose at the engine and the radiator lower hose at the water pump. On a vehicle with automatic transmission disconnect the transmission oil cooler lines from the radiator.
3. Remove the cooling fan and spacer (or fan drive clutch) and power steering pump drive belt (if so equipped). Remove the radiator. Remove the oil level dipstick.
4. Disconnect the oil pressure sending unit wire at the sending unit and the flexible fuel line at the fuel tank line.

Disconnect the accelerator cable at the carburetor. Remove the accelerator retracting spring. Remove the accelerator cable bracket from the intake manifold. Position the accelerator cable and body ground strap out of the way.

On a vehicle with automatic transmission, disconnect the kickdown rod at the carburetor. Remove the kickdown rod retracting spring. Disconnect the transmission vacuum line at the engine.

On a vehicle with power steering, remove the power steering pump from the mounting bracket. Remove the power steering hose bracket bolt. Wire the power steering pump in a position that will prevent the fluid from draining out. Remove the power steering pump bracket, coil bracket, and compressor bracket and compressor assembly (if equipped with air conditioning). Remove the coil. Position the compressor (with lines attached) out of the way. On a vehicle with power brakes, disconnect the brake vacuum hose at the pipe and position the hose out of the way.

5. Disconnect the heater hoses at the water pump and intake manifold and remove the heater hose from the automatic choke bracket. Disconnect the coolant temperature sending unit at the sending unit. Remove the wire loom from the clips on the left valve rocker arm cover and position it out of the way.

On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, **leaving the refrigerant lines attached.**

6. Remove the battery ground cable and alternator ground cable bolt at the engine. Remove the alternator mounting bolts and spacer, and position the alternator out of the way.
7. Disconnect the fuel inlet line at the pump.
8. Raise the front of the vehicle. Remove the starter.
9. Disconnect the muffler inlet pipes from the exhaust manifolds.
10. Remove the engine support insulator to intermediate support bracket nuts, and loosen the right side support insulator to engine bolts.

On a vehicle with an automatic transmission, remove the flywheel housing cover. Remove the oil cooler lines retaining clip from the engine block. Disconnect the converter from the flywheel. Secure the converter assembly in the housing. Remove the remaining flywheel housing to engine bolts, and remove the transmission fluid filler tube bracket.

On a vehicle with a manual-shift transmission, remove the flywheel housing inspection cover and the clutch pedal retracting spring. Disconnect the clutch release bracket at the equalizer rod and remove the bracket from the engine. Remove the remaining flywheel housing to engine bolts.

11. Lower the vehicle; then support the transmission. Install the engine

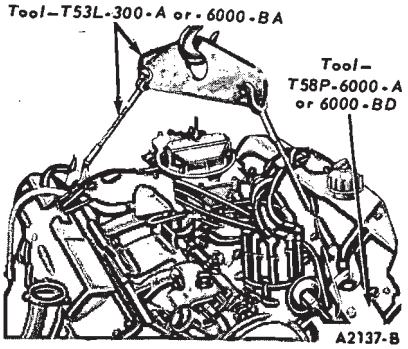

FIG. 48—Typical Engine Lifting Bracket and Sling

left lifting bracket on the front of the left cylinder head, and install the engine right lifting bracket at the rear of the right cylinder head. Then attach the engine lifting sling (Fig. 48).

12. Remove the flywheel or converter housing to engine upper bolts.

13. Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the engine compartment.

INSTALLATION

1. Attach the engine lifting brackets and sling (Fig. 48).

2. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes and the dowels in the block engage the holes in the flywheel housing.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. **If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.**

3. Install the flywheel or converter housing upper bolts.

4. Remove the transmission jack. Lower the engine until the front support insulators are properly positioned in the intermediate support brackets. Torque the right side insulator bolts to specifications. Disconnect the engine lifting sling and remove the lifting brackets.

5. Raise the vehicle and install the remaining flywheel housing to cylinder block attaching bolts. Torque the bolts to specifications.

6. Install the lock washers and nuts on the engine support insulators. Torque both insulator nuts to specifications.

7. Install new muffler inlet pipe gaskets, and connect the muffler inlet pipes to the exhaust manifolds. Torque the nuts to specifications.

8. On a vehicle with an automatic transmission, remove the retainer securing the converter in the housing. Attach the converter to the flywheel. Install the transmission fluid filler tube bracket. Install the flywheel housing cover assembly. Install the oil cooler lines bracket. Connect the kickdown rod to the transmission.

On a vehicle with a manual-shift transmission, install the clutch bracket. Connect the clutch release rod and install the clutch retracting spring. Install the flywheel housing lower cover.

9. Install the starter and transmission filler tube bracket. Attach the starter cable.

10. Lower the vehicle. Install the power steering pump bracket, coil bracket, and compressor and bracket assembly (if equipped with air conditioning).

11. Connect the flexible fuel line and the oil pressure sending unit wire.

12. Place the alternator drive belt on the crankshaft pulley. Install the power steering pump and adjust the belt tension to specifications. On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications.

13. Install the alternator and attach the battery ground cable. Connect the alternator wires and coolant temperature sending unit wire. Connect the heater hoses at the water pump and intake manifold.

14. Install the ignition coil and connect the coil primary and high tension wires. Position the wire loom in the retaining clips on the left valve rocker arm cover. Install the oil level dipstick.

15. On a vehicle with an automatic transmission, connect the kickdown rod to the carburetor. Install the kickdown rod retracting spring. Connect the transmission vacuum line.

Install the accelerator cable bracket and body ground strap. Connect the accelerator cable to the carburetor and install the retracting spring.

16. Install the radiator. Connect the radiator upper and lower hoses. Install the hood.

On a vehicle with an automatic transmission, connect the transmission oil cooler lines.

17. Install the fan and spacer (or fan drive clutch). Torque the bolts to specifications. Position the alternator drive belt and adjust the tension to specifications. Tighten the alternator mounting bolts to specifications. Connect the battery positive cable.

On a vehicle with air conditioning, adjust the compressor belt tension to specifications.

18. Fill and bleed the cooling system. Connect the heater hose at the water pump. Fill the crankcase with the proper grade and quantity of oil. Install the hood.

19. Install the air cleaner and operate the engine at fast idle, checking all gaskets and hose connections for leaks.

20. Adjust the accelerator cable and the idle speed and fuel mixture following the procedure in Part 23-01.

On a vehicle with an automatic transmission, adjust the transmission control linkage.

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REMOVAL

1. Drain the cooling system and the crankcase. Remove the hood and the air cleaner. Disconnect the battery ground cable.

2. Disconnect the radiator upper hose at the engine and the radiator lower hose at the water pump. Disconnect the transmission oil cooler lines from the radiator.

3. Remove the radiator. Remove the oil level dipstick. Remove the cooling fan and spacer and power steering drive belt (if so equipped).

4. Disconnect the oil pressure sending unit wire at the sending unit, and the flexible fuel line at the fuel tank line. Plug the fuel tank line.

5. Disconnect the accelerator rod at the carburetor. Remove the accelerator retracting spring.

Disconnect the automatic transmission kickdown rod at the carburetor. Remove the kickdown rod retracting spring. Disconnect the transmission vacuum line at the engine.

On a vehicle with power steering, remove the power steering pump from the mounting bracket. Remove the power steering hose bracket bolt. Wire the power steering pump in a position that will prevent the oil from draining out. Remove the power steering pump bracket, coil bracket, and compressor bracket and compressor assembly (if equipped with air conditioning). Remove the coil. Position the compressor with lines at-

tached out of the way. On a vehicle with power brakes, disconnect the brake vacuum hose at the pipe and position the hose out of the way.

On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, **leaving the refrigerant lines attached.**

6. Disconnect the heater hoses at the water pump and intake manifold, the alternator wires at the alternator, and the water temperature sending unit at the sending unit.

7. Disconnect the wire loom at the distributor and ignition coil. Remove the wire loom from the clips on the left valve rocker arm cover and position it out of the way.

8. Raise the front of the vehicle. Disconnect the muffler inlet pipe at the right exhaust manifold. Remove the exhaust control valve.

9. Disconnect the engine front support insulators at the frame. Raise the engine approximately 1 or 2 inches to provide necessary clearance to remove the right exhaust manifold.

10. Remove the right exhaust manifold. Disconnect the muffler inlet pipe at the left exhaust manifold.

11. Disconnect the starter cable. Remove the starter.

12. Remove the flywheel housing cover. Remove the oil cooler lines retaining clip from the engine block. Disconnect the converter from the flywheel. Secure the converter assembly in the housing. Remove the remaining flywheel housing to engine bolts, and remove the transmission fluid filler tube bracket.

13. Lower the vehicle and support the transmission. Install the engine left lifting bracket on the front of the left cylinder head, and install the engine right lifting bracket at the rear of the right cylinder head, then attach the engine lifting sling (Fig. 48).

14. Remove the converter housing to engine upper bolts.

15. Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the engine compartment.

INSTALLATION

1. Clean the muffler inlet pipe gasket surfaces and both sides of the exhaust control valve assembly.

2. Attach the engine lifting brackets and sling (Fig. 48).

3. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes and the dowels in the block engage the holes in the flywheel housing.

4. On a vehicle with an automatic transmission, start the converter pilot into the crankshaft. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the converter housing.

5. Install the converter housing upper bolts. Install the remaining converter housing to engine block retaining bolts.

6. Raise the front of the vehicle. Install the starter. Connect the starter cable.

7. Raise the engine approximately 1 or 2 inches and position the right exhaust manifold. Install and torque the retaining bolts to specifications.

8. Make sure the engine support insulator bolts are properly aligned with the support brackets on the frame. Completely lower the engine and install the engine support insulator lock washers and nuts. Torque the nuts to specifications.

9. Disconnect the engine lifting sling and remove the lifting brackets.

10. Place new gaskets on both sides of the exhaust control valve and position it over the inlet pipe studs on the right exhaust manifold. Connect the muffler inlet pipe to the exhaust manifold and torque the nuts to specifications.

11. Position a new gasket to the left exhaust manifold and connect the muffler inlet pipe to the manifold. Install and torque the nuts to specifications.

12. Remove the retainer securing the converter in the housing. Attach the converter to the flywheel. Install the transmission fluid filler tube bracket. Install the flywheel housing cover assembly. Install the oil cooler lines bracket. Connect the kickdown rod to the transmission.

13. Remove the support from the transmission and lower the vehicle.

14. Install the fan and spacer (or fan drive clutch). Torque the bolts to specifications. Position the alternator drive belt and adjust the tension to specifications. Tighten the alternator mounting bolts to specifications. Connect the battery positive cable.

On a vehicle with air conditioning, adjust the compressor belt tension to specifications.

15. Connect the alternator wires, the water temperature sending unit wire, and connect the heater hose at the intake manifold. Connect the battery ground cable.

16. Connect the flexible fuel line and oil pressure sending unit wire.

17. Install the power steering pump bracket, coil bracket, and compressor and bracket assembly (if equipped with air conditioning).

Place the alternator drive belt on the crankshaft pulley. Install the power steering pump and adjust the belt tension to specifications. On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications.

18. Connect the coil primary and high tension wires. Connect the wire loom at the distributor. Position the wire loom in the retaining clips on the left valve rocker arm cover.

19. On a vehicle with an automatic transmission, connect the kickdown rod to the carburetor. Install the kickdown rod retracting spring. Connect the transmission vacuum line. Install the oil level dipstick. Install the accelerator retracting spring. Connect the accelerator rod and adjust the accelerator linkage.

20. Install the radiator. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines. Install the hood.

21. Fill and bleed the cooling system. Connect the heater hose at the water pump. Fill the crankcase with the proper grade and quantity of oil.

22. Install the air cleaner, and operate the engine at fast idle and check all gaskets and hose connections for leaks.

23. Adjust the accelerator cable and the idle speed and fuel mixture as required, following the procedures in Part 23-01.

On a vehicle with an automatic transmission, check and adjust the transmission control linkage.

4 MAJOR REPAIR OPERATIONS

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install it on a work stand. For engine removal and installation procedures, refer to Section 3.

When installing nuts or bolts that must be torqued, oil the threads with light weight engine oil. **Do not oil threads that require oil resistant or water-resistant sealer.**

CRANKSHAFT

The crankshaft and related parts are shown in Fig. 49.

REMOVAL

1. Disconnect the spark plug wires. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the fuel pump. Slide the water pump bypass hose clamp toward the intake manifold. Remove the water pump. On Thermactor engines, remove the air pump and brackets from the right cylinder head.
3. Remove the accessory drive pulley (if so equipped). Remove the crankshaft damper cap screw and washer. Remove the power steering drive pulley. Install the puller on the damper (Fig. 22) and remove the damper.
4. Remove the crankshaft sleeve.
5. Remove the carburetor fuel inlet line. Remove the fuel pump. Remove the cylinder front cover and air conditioning idler pulley assembly (if so equipped). Remove the cover gasket.
6. Remove the crankshaft front oil slinger. Check the timing chain deflection, then remove the timing chain and sprockets by following the applicable steps under Cylinder Front Cover Removal.
7. Invert the engine on the work stand. Remove the flywheel, and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump and inlet tube and screen assembly.
8. **Make sure all bearing caps (main and connecting rods) are marked so that they can be installed in their original locations.** Remove the connecting rod bearing caps. Turn the crankshaft until the connecting rod from which the cap is being removed is down and remove the cap. Push the connecting rod and piston assembly up into the cylinder.
9. Remove the main bearing caps.
10. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.**

INSTALLATION

1. Remove the rear journal oil seal from the block and rear main bearing cap. Remove the rear main bearing cap to block side seals.
2. Remove the main bearing inserts from the block and bearing caps.
3. Remove the connecting rod bearing inserts from the connecting rod and caps.
4. If the crankshaft main bearing journals have been refinished as stated in Part 21-01, Section 2, to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort

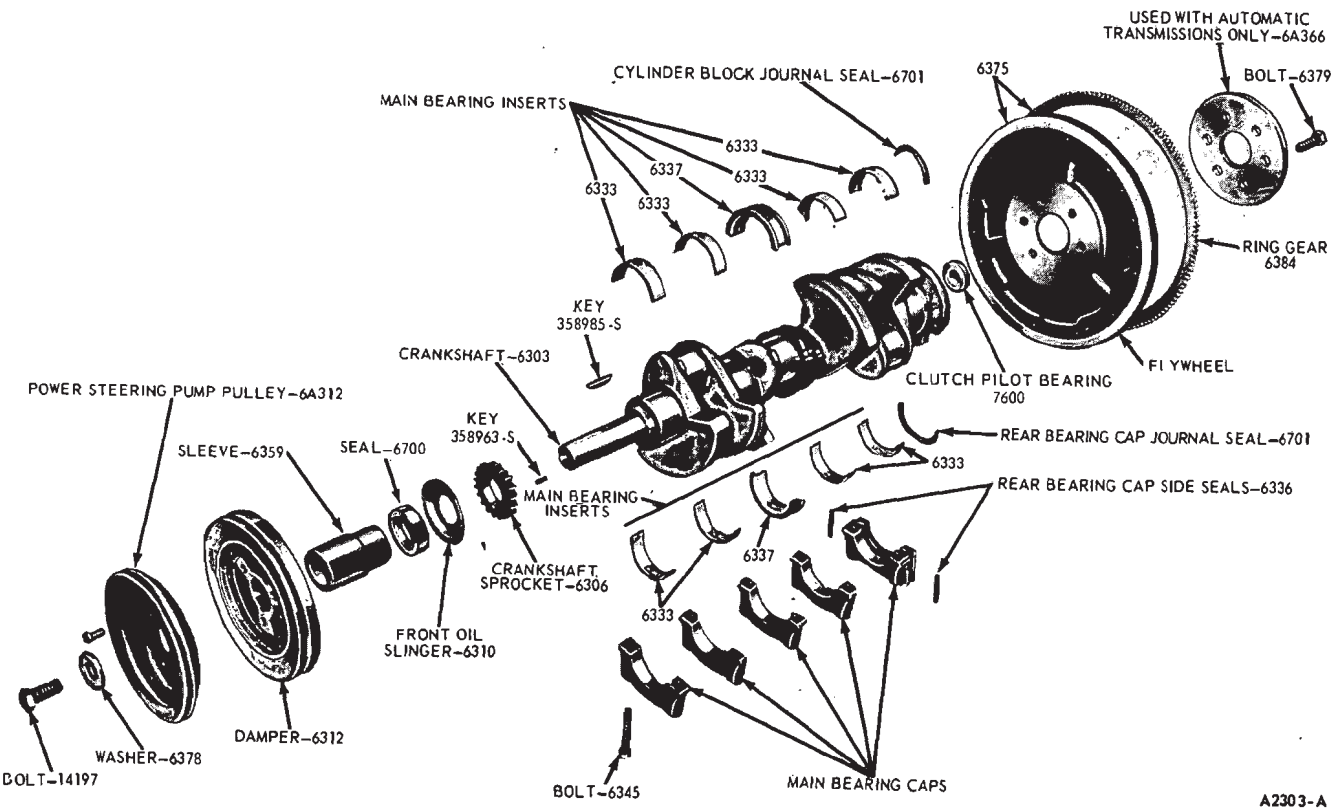

FIG. 49—Typical Crankshaft and Related Parts

the bearing and cause a failure.

5. Place the upper main bearing inserts in position in the bores with the tang fitting in the slot provided.

If the oil hole does not line up with the cylinder block oil passage, check the holes with a rod corresponding to the following diameters:

No. 1 Bearing—7/64 inch
No. 2 Bearing—9/64 inch
No. 3 Bearing—9/32 inch
No. 4 Bearing—5/32 inch
No. 5 Bearing—9/32 inch

If the rod passes through both the bearing and the block, sufficient lubrication is assured.

6. Install the lower main bearing inserts in the bearing caps.

7. Dip the seal halves in clean engine oil. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34) and approximately 3/8 inch protruding above the partial surface.

8. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

9. Check the clearance of each main bearing. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

10. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

11. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 34), allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed.

12. Dip the side seals in light engine oil; then immediately install them in the grooves. **Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion.** It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

13. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.

14. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**

15. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original locations.** Torque the bearing cap bolts to specifications.

16. Install the thrust bearing cap with the bolts finger-tight.

17. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 50).

18. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

19. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications (Fig. 50).

20. Check the crankshaft end play by following the procedure in Part 8-1, Section 1.

21. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Main Bearing Replacement.

22. After the connecting rod bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

23. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.

24. Install the connecting rod cap. Torque the nuts to specifications.

25. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Fig. 38).

26. Install the engine rear cover plate; then position the flywheel on the crankshaft. Install the attaching bolts. Torque the bolts to specifications.

On a flywheel for a manual-shift transmission, use tool 7563 to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

27. Install the timing chain and sprockets, cylinder front cover and crankshaft damper, following the procedures under Cylinder Front Cover Installation.

28. Clean the oil pan, oil pump and oil pump screen following the procedures in Part 21-01. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and oil

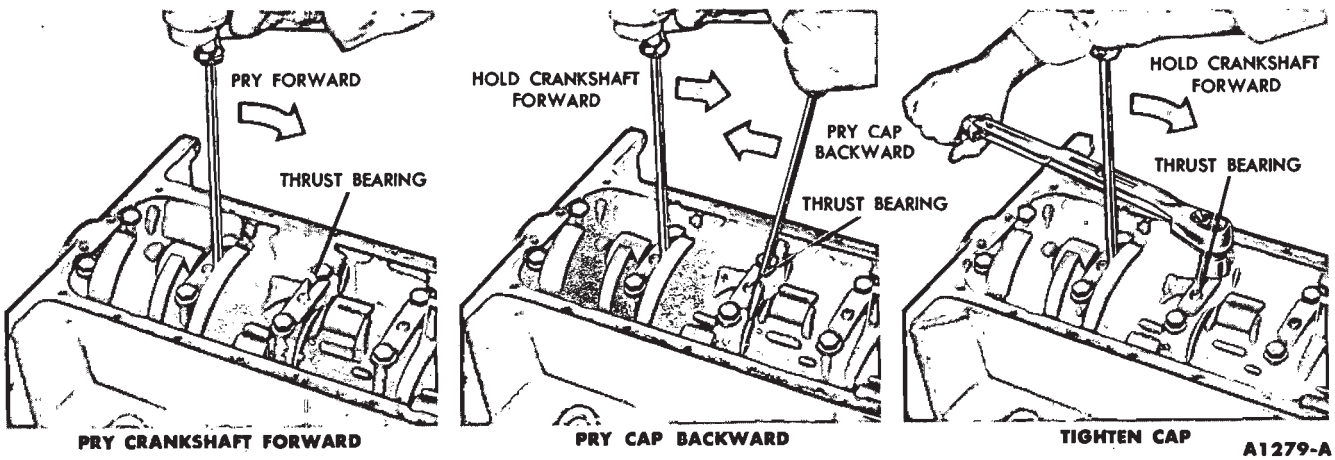

FIG. 50—Thrust Bearing Alignment

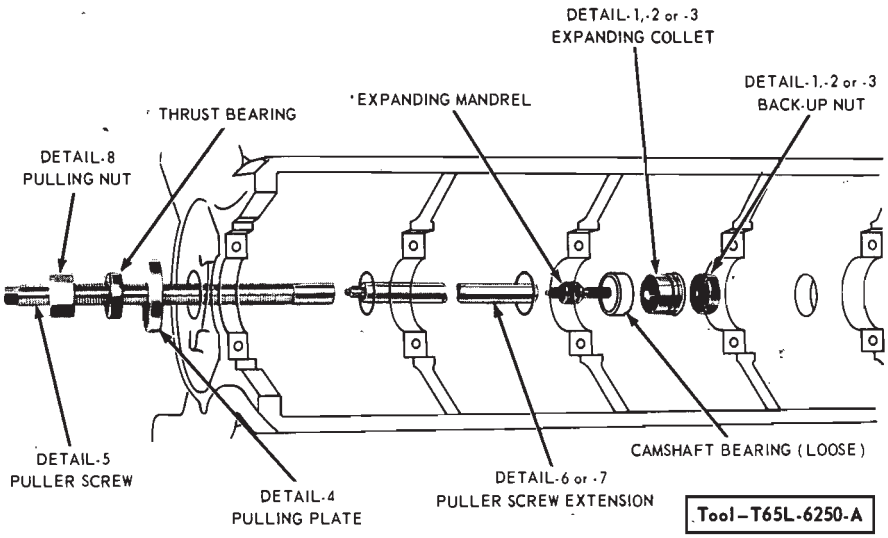

FIG. 51—Camshaft Bearing Replacement

pan.

29. Install the oil filter, fuel pump and carburetor fuel inlet line. Install the spark plugs. On Thermactor engines, install the air pump and brackets on the right cylinder head.

30. Remove the engine from the work stand.

CAMSHAFT BEARING REPLACEMENT

Camshaft bearings are available pre-finished to size or standard and 0.015-inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

1. Remove the camshaft, flywheel and the crankshaft following steps 3 through 8 under Camshaft Removal. Push the pistons to the top of the cylinders.

2. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 51).

If the camshaft bearings are being removed with the tool shown in Fig. 51, the following procedure will apply. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

3. Position the new bearing at the bearing bores, and press them in place with the tool shown in Fig. 51. Be sure to center the pulling plate and the puller screw to avoid damage to the bearing. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. **Failure to use the correct expanding collet can cause severe bearing damage.** Align the oil holes in the bearings with the oil holes in the cylinder block when the bearings are installed. **Be sure the front bearing is installed the specified dimension below the front face of the cylinder block (Fig. 52).**

4. Install the core plug as detailed in Part 21-01, Section 2.

5. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures in Section 2 or Section 4, except do not check the connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Remove the engine from the work stand.

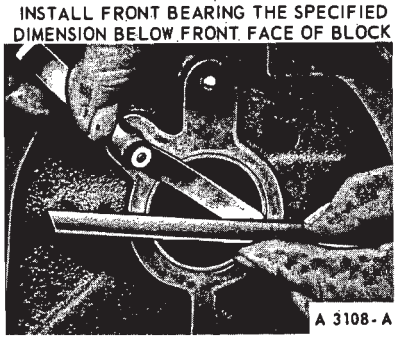

FIG. 52—Camshaft Front Bearing Measurement

CYLINDER ASSEMBLY REPLACEMENT

DISASSEMBLY

Follow steps 1 thru 11, 13 thru 20, and 24 thru 26 under Engine Disassembly. Remove the cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs and remove the cylinder assembly from the work stand. Clean the gasket and seal surfaces of all parts and assemblies (refer to Part 21-01, Section 3).

ASSEMBLY

Install the replacement cylinder block assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the oil cylinder assembly to the new cylinder assembly, following the procedures in steps 22 thru 34 and 41 thru 62, under Engine Assembly. Check all assembly clearances.

CYLINDER BLOCK REPLACEMENT

Before replacing a cylinder block, determine if it is repairable, and make the necessary repairs following the procedures in Part 21-01, Section 2.

DISASSEMBLY

Follow steps 1 thru 34 under Engine Disassembly. Remove the cylinder head dowels and cylinder block drain plugs. Remove each intake and exhaust manifold and cylinder head as assemblies. Remove the cylinder block from the work stand. Clean the gasket and seal surfaces of all parts and assemblies (Part 8-1, Section 3).

ASSEMBLY

Install the replacement cylinder block on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder block to the new cylinder block, following steps 7 thru 62. Check all assembly clearances. Install each manifold and cylinder head as an assembly.

ENGINE DISASSEMBLY

1. Install the engine on the work stand.

2. Remove the distributor cap and spark plug wires as an assembly.

3. Remove the vacuum hoses from the distributor and distributor vacuum control valve. Tag or identify each hose to facilitate installation and connection to the proper ports.

Remove the carburetor fuel inlet line. Remove the fuel pump and discard the gasket.

4. Slide the clamp on the water pump by-pass hose toward the water pump. Remove the automatic choke air heat tube and air inlet tube. On Thermactor engines, disconnect the air and vacuum hoses. Remove the air supply pump, air manifold assembly, air bypass valve, and air and vacuum hoses and brackets. Remove the valve rocker arm covers and positive crankcase ventilation system components.

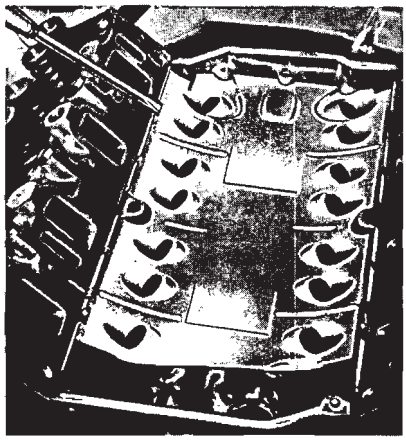

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FIG. 53—Removing Baffle Plate

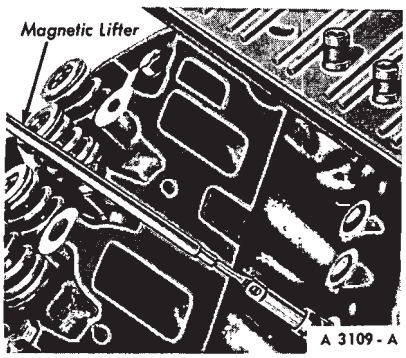

FIG. 54—Removing Valve Lifter

Starting at the No. 4 cylinder, loosen the right rocker arm shaft support bolts in sequence, two turns at a time. After the bolts are all loosened, remove the valve rocker arm shaft assembly and the oil baffle plate. Starting at the No. 5 cylinder, follow the same procedure on the left valve rocker arm shaft support bolts.

5. Remove the valve push rods in sequence and put them in a rack so that they can be installed in their original bore.

6. Remove the distributor hold-down bolt and clamp and remove the distributor.

7. Remove the intake manifold attaching bolts.

8. Install standard eye bolts with 5/16-18 threads in the left front and right rear rocker arm cover screw holes and attach the engine lifting sling (Fig. 9).

9. Raise the intake manifold and carefully remove it from the engine. Discard the intake manifold gaskets and seals.

10. Remove the baffle plate from the valve push rod chamber floor by prying up on the baffle with a screwdriver (Fig. 53).

11. Lift the valve lifters or tappets from the cylinder block and place them in a rack so that they can be installed in their original bore (Fig. 54).

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

12. Remove the exhaust manifolds and the spark plugs. Remove the automatic choke air chamber cover from the right exhaust manifold.

13. Remove the cylinder head bolts.

14. Lift the cylinder heads off the block. **Do not pry between the head and the block.** Discard the cylinder head gaskets.

15. Remove the oil filter. Remove the oil filter adapter assembly and oil pressure sending unit as an assembly. Discard the gasket.

16. Remove the alternator, bracket and drive belt.

17. Remove the water pump, pulley and fan as an assembly. Remove the accessory drive pulley (if so equipped).

18. On a vehicle with power steering remove the power steering pulley. Remove the damper (Fig. 22).

19. Remove the crankshaft sleeve.

20. Remove the cylinder front cover. Discard the gasket. Remove the crankshaft front oil slinger.

21. Check the timing chain deflection by following the procedure in Parts 8-1, Section 1.

22. Remove the camshaft sprocket cap screw and the fuel pump eccentric. Remove the sprockets and timing chain as an assembly (Fig. 24). Remove the crankshaft sprocket key.

23. Remove any ridge and/or carbon deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the top of the piston to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.** After the ridge has been removed, remove the cutter from the cylinder bore.

24. On a flywheel for a manual-shift transmission, mark the pressure plate cover so that it can be installed in its original position. Remove the clutch pressure plate and cover assembly. Remove the flywheel. Remove the rear cover plate.

25. Remove the oil pump and inlet tube as an assembly. Remove the oil pump intermediate shaft. Discard the oil pump gasket.

26. Make sure all connecting rods and caps are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the rod cap.

27. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the connecting rod journal or the cylinder wall when removing the piston and rod.**

28. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

29. Remove the main bearing caps.

30. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**

31. Remove the rear journal oil seal from the block and rear bearing cap, and remove the cap to block side

seals.

32. Remove the main bearing inserts from the block and bearing caps. Install the main bearing caps in their original positions.

33. Carefully remove the camshaft. Avoid damaging the journals and lobes.

34. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 51).

ENGINE ASSEMBLY

If the cylinder block is to be replaced, transfer the cylinder head dowels and cylinder block drain plugs to the new cylinder block. Also, omit steps 1 thru 6 below, if a new cylinder block is used.

1. If the original cylinder block is used, remove the glaze from the cylinder bores by following the procedures in Part 21-01, Section 2.

2. Invert the engine on the work stand.

3. Position the new camshaft bearings at the bearing bores and press them in place with the tool shown in Fig. 51. Align the oil holes in the cylinder block when the bearings are installed. **Be sure the camshaft front bearing is installed to the specified dimension below the front face of the cylinder block (Fig. 52).**

4. Check the oil passage that feeds the rocker arm shafts for obstructions by squirting oil into the opening on each cylinder bank and observing the flow through the oil holes at Nos. 2 and 4 bearings.

5. Install the core plug as detailed in Part 21-01, Section 2.

6. Oil the camshaft journals and apply Lubriplate to all lobes; then carefully slide it through the bearings. Check the camshaft end play and correct as required.

7. Be sure that the rear oil seal grooves are clean. Dip the seal halves in clean engine oil. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34) and approximately 3/8 inch protruding above the parting surface.

8. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

9. Install the lower main bearing inserts in the bearing caps.

10. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

11. Check the clearance of each main bearing following the procedure under Main Bearing Replacement.

12. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

13. Be sure that the oil seal grooves in the rear main bearing cap are clean. Install the lower seal in the rear main bearing cap are clean. Install the lower seal in the rear main bearing cap with the seal lip toward the FRONT of the engine (Fig. 34). Allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.**

14. Install the rear main bearing cap and the remainder of the caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original locations.** Torque the bearing cap bolts to specifications.

15. Dip the side seals in light engine oil; then immediately install them in the grooves. **Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion.** It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

16. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**

17. Install the thrust bearing cap following steps 11 thru 14 under Crankshaft Installation. Check the crankshaft end play by following the procedure in Part 21-01, Section 1.

18. Turn the engine on the work stand so that the front end is up.

19. Install the pistons and connecting rods by following steps 1 thru 9 under Piston and Connecting Rod Assembly Installation.

20. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24). Be sure the timing marks on the sprockets are positioned as shown in Fig. 23.

21. Lubricate the timing chain and sprockets with engine oil.

22. Install the fuel pump eccentric and the camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Install the crankshaft front oil slinger.

23. Clean the cylinder front cover and the cylinder block gasket surfaces. Grease and install a new crankshaft front oil seal (Fig. 25).

24. Coat the gasket surface of the block and cover and the cover bolt threads with sealer. Position a new gasket on the block.

25. Install the alignment pilot tool on the cylinder front cover so that the keyway in the pilot aligns with the key in the crankshaft. Position the cover and pilot over the end of the crankshaft and against the block (Fig. 27).

26. Install the cylinder front cover bolts finger-tight. While pushing in on the pilot, torque the cover bolts to specifications. Remove the pilot.

27. Apply Lubriplate to the outer surface (front oil seal contact surface) of the crankshaft sleeve, and install the sleeve.

28. Apply a white lead and oil mixture to the inside diameter of the crankshaft damper.

29. Line up the damper keyway with the key on the crankshaft, and install the damper on the crankshaft (Fig. 38). Install the power steering pulley on the crankshaft damper. Install the damper cap screw and washer, and torque the screw to specifications.

30. Clean the water pump gasket surfaces and apply sealer. Position new gaskets on the pump and install the water pump, pulley, and fan as an assembly.

31. Using a new gasket, install the fuel pump.

32. Turn the engine on the work stand so that the top of the engine is up.

33. Clean the cylinder head and block gasket surfaces. All engines use a specially treated composition gasket. **Do not apply sealer to the composition cylinder head gasket.** Guided by the word FRONT on the gasket, install the head gasket over the cylinder head dowels.

34. Place the cylinder head on the engine.

35. The cylinder head bolt tightening procedure is performed in three progressive steps. Torque the bolts in sequence (Fig. 20) to 70 ft-lbs, then to 80 ft-lbs, and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued, if required.

36. Coat the mating surfaces of the exhaust manifold with a light film of graphite grease.

37. Using a new gasket, install the automatic choke air chamber cover on the right exhaust manifold. **Be sure the cover is securely fastened.**

38. Position a new gasket over the muffler inlet pipe studs of the exhaust manifolds.

39. Position the exhaust manifolds on the cylinder heads and install the attaching bolts and flat washers.

Torque the attaching bolts to specifications, working from the center to the ends.

40. Install the spark plugs.

41. Invert the engine on the work stand. Position the oil pump drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

42. With the stop properly positioned, insert the oil pump drive shaft into the oil pump.

43. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

44. Position a new gasket on the pump housing and install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate shaft into a new position.**

45. Position a new gasket on the oil pan and place the pan on the block. Install the attaching screws and torque them from the center outward to specifications.

46. Invert the engine on the work stand. Install the baffle plate in the valve push rod chamber. Position one side of the baffle plate and press the other side into place.

Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid. Coat the outside of each valve lifter with engine oil to provide initial lubrication. Place each lifter in the bore from which it was removed.

47. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil.

48. Coat the intake manifold and cylinder block seal surfaces with a quick-setting seal adhesive. Apply a non-hardening sealer to the mating lines of the cylinder heads and cylinder block.

49. Position new seals on the cylinder block and new gaskets on the cylinder heads. **Be sure the seals are properly positioned during installation as the adhesive sticks to the seals immediately on contact.** Position the manifold gasket slots over the end tabs on the seals. Coat these four connections with a non-hardening sealer. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

50. Install the eye bolts in the intake manifold and attach the engine lifting sling and carefully lower the intake manifold on the engine (Fig. 9).

51. Position the intake manifold. **After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If seals are not in place, remove the intake manifold and position the seals.**

52. Start the water pump bypass hose on the intake manifold.

53. Be sure the holes in the manifold gaskets and manifold are in alignment. Apply a non-hardening, oil-resistant sealer to the under side of each manifold attaching bolt head. Install the manifold attaching bolts. Torque the intake manifold bolts in two steps (Fig. 11).

Torque all bolts in sequence to specifications.

After completing the remaining assembly steps; operate the engine until it reaches normal operating temperature; then retorque the manifold bolts in sequence to specifications.

54. Remove the engine lifting sling and eye bolts.

55. Refer to Valve Rocker Arm Shaft Assembly Installation and install the valve rocker arm shaft assemblies by following steps 1 thru 8.

56. Install the automatic choke air heat tube and air inlet tube.

57. Rotate the crankshaft damper until the No. 1 piston is on TDC of the compression stroke; then position the distributor in the block with the rotor at the No. 1 firing position and the points open. Install the hold down clamp.

58. Install the distributor cap and spark plug wire. Connect the spark plug wires.

59. Connect the carburetor fuel inlet line to the fuel pump. Using a new clamp, connect the line to the fuel filter. Install the distributor vacuum hoses. Be sure they are connected to the proper ports.

60. Install the engine rear cover plate. Position the flywheel on the crankshaft and install the attaching bolts. Torque the bolts alternately to specifications.

On a flywheel for a manual-shift transmission, use tool 7563-E to locate the clutch disc. Install the pressure plate.

61. Clean the oil filter adapter gasket surfaces. Apply oil-resistant sealer to a new adapter gasket, and install the adapter assembly and gasket.

62. Clean the adapter filter recess. Coat the gasket on a new filter with oil. Place the filter in position on the adapter. Hand tighten the filter until the gasket contacts the adapter face, and advance it 1/2-turn.

On Thermactor engines install the air bypass valve, air manifold assembly and air supply pump. Install the air and vacuum hoses and brackets.

63. Remove the engine from the work stand, and install it in the vehicle. Install the air cleaner; fill and bleed the cooling system; fill the crankcase with the proper grade and quantity of engine oil; then operate the engine and check for oil and coolant leaks. Check the ignition timing; adjust the engine idle speed, idle fuel mixture, accelerator cable, and anti-stall dashpot (if applicable). Connect the distributor vacuum hose.

On a vehicle with an automatic transmission, adjust the transmission control linkage.

5 SPECIFICATIONS

NOTE: All specifications are given in inches unless otherwise noted

ENGINE IDENTIFICATION

WARRANTY PLATE CODE AND APPLICATION

Engine	Ford	Mercury	Cougar	Fairlane	Falcon	Montego	Mustang	Fairlane Ranchero	Lincoln Continental Mark III	Thunderbird	Meteor
390-2V	Y	Y									Y
①428-4V CJ			Q				Q				
①428-4V CJ Ram Air			R				R				
①428-4V P	P	P									

① Thermactor equipped

CA1057-A1

GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft-Lbs.
390-2V	9.5:1	4.05 x 3.784	52.48	270 @ 4400	390 @ 2600
428-P	10.5:1	4.13 x 3.984	54.58	360 @ 5400	459 @ 3200
428-CJ	10.6:1			335 @ 5200	440 @ 3400

CA1057-A2

Engine	Compression Pressure PSI (Sea Level @ Cranking Speed	Engine Idle Manifold Vacuum	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.)
390	When checking compression, take the highest compression reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	17	35-60		New 140 Used 110
428		17		1-5-4-2-6-3-7-8	

CA1057-A3

CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width Intake	Valve Seat Width Exhaust	Valve Seat Angle	Valve Seat Runout (Maximum)	Arrangement (Front to Rear)	Surface Flatness ①
390-428 P	68.1-71.1	0.3728-0.3738	0.060-0.080	0.070-090	Intake 30° Exhaust 45°	0.0015	Right and Left E-I-E-I-I-E-I-E	0.003 in any 6 in. 0.007 Overall
428 CJ	72.7-75.7							

① Head Gasket Surface Finish R.M.S. ..... 90–150.

CA1057-A4

VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Shaft O.D.	Rocker Arm To Rocker Shaft Clearance ①	Rocker Arm Bore Diameter	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
						Standard Diameter	Clearance To Bore ②	Hydraulic Lifter Leakdown Rate
390-428	0.839-0.840	0.002-0.005	0.842-0.844	1.73:1	0.025	0.8740 0.8745	0.0007-0.0027	5-50 Seconds Maximum—Measured at 1/16 inch plunger travel

①Wear Limit—0.0060 ②Wear Limit—0.005

CA1057-A5

VALVE SPRINGS

Engine	Valve Spring Pressure Lbs. @ Specified Length		Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit			
390	85–95 @ 1.820 209–231 @ 1.380	77 @ 1.820 188 @ 1.380	2.12	1 13/16–1 27/32	5/64 (.078)
428 Police, 428 CJ	80–90 @ 1.820 255–280 @ 1.320	72 @ 1.820 230 @ 1.320	2.06		

CA1057-AA5

VALVES

Engine	Valve Stem To Valve Guide Clearance		Hydraulic Lifters		Valve Head Diameter		Valve Face Angle ②	Allowable Valve Stem Tip Length
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust		
390	0.0010-0.0027 ①	0.0015-0.0032 ①	0.100-0.200	0.100-0.150	2.022-2.037	1.551-1.566	Intake and Exhaust 44°	N.A.
428 P					2.022-2.037	1.551-1.566		
428 CJ	0.0015-0.0032				2.082-2.097	1.645-1.660	Intake 29° Exhaust 44°	

①Wear Limit 0.0055 All engines

②Valve face runout All Engine ..... Maximum 0.0020

CA1057-A6

VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
390	0.3711-0.3718	0.3706-0.3713	0.3741-0.3748	0.3736-0.3743	0.3861-0.3868	0.3856-0.3863	0.4011-0.4018	0.4006-0.4013
428 P								
428 CJ								

CA1057-A7

CAMSHAFT

Engine	Lobe Lift①		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance	
	Itake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
390-2V	0.2470	0.2490	0.4270	0.4300	0.001-0.007	0.009	0.001-0.003	0.006
428 P	0.2780	0.2830	0.4810	0.4900				
428 CJ								
①Maximum allowable lobe lift loss (All engines) 0.005								

CA1057-A8

Item	Bearing	390, 428
Camshaft Journal Diameter– Standard①	(No. 1)	2.1238-2.1248
	(No. 2)	
	(No. 3)	
	(No. 4)	
	(No. 5)	
Camshaft Bearings Inside Diameter	(No. 1)	2.1258-2.1268
	(No. 2)	
	(No. 3)	
	(No. 4)	
	(No. 5)	
Camshaft Bearing Location②	(No. 1)	0.0050-0.0200

①Camshaft journal maximum runout
All engines 0.0005
Camshaft journal maximum out-of-round
390 ..... 0.0005
All Others 0.0010
②Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.

CA1057-A9

CAMSHAFT VALVE TIMING EVENTS

Engine	Intake Valve		Exhaust Valve	
Model	Opens BTC	Closes ABDC	Opens BBDC	Closes ATDC
390-2V	0.004 @ 13°	0.006 @ 63°	0.004 @ 63°	0.005 @ 23°
428 Police & CJ	0.004 @ 18°	0.006 @ 72°	0.004 @ 82°	0.006 @ 28°

CA1057-A10

CAMSHAFT DRIVE MECHANISM

Engine	Camshaft Sprocket Face Runout T.I.R. Max.	Timing Chain Deflection (Maximum)
390	0.006	0.500
428		

CA1057-A12

CYLINDER BLOCK

Engine	Cylinder Bore Diameter①	Cylinder Bore Diameter 0.003 O.S.	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness②
390	4.0500-4.0524	4.0524-4.0536	0.8752-0.8767	2.9417-2.9425	0.4525-0.4535	0.003 inch in any 6 inches or 0.007 inch Overall
428	4.1300-4.1324	4.1324-4.1336				

①Maximum out-of-round 0.001
Wear Limit 0.005
Cylinder bore surface finish RMS
All 15-35

②Head gasket surface finish RMS 60–150

CA1057-A13

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter①	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max.	Thrust Bearing Journal Length	Main Bearing Surface Finish R.M.S. Maximum	
						Journal	Thrust Face
390	2.7484-2.7492	0.004	0.001	0.0003 Per Inch	1.124-1.126	12	20 Front 20 Rear
428							

①Wear Limit 0.0035
②Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)

CA1057-A14

CRANKSHAFT AND FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter①	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Crankshaft To Rear Face Of Block Runout T.I.R. Max.	Flywheel Clutch Face Runout	Flywheel O.D. Runout Transmission	
						Standard	Automatic
390	2.4380-2.4388	0.0003 Per Inch	0.004-0.010 ②	0.010	0.010	0.018	0.017
428							

①Wear Limit 0.012 ② Wear Limit 0.014
②Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)

CA1057-A15

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearings			Main Bearings		
	To Crankshaft Clearance		Wall Thickness-Standard①	To Crankshaft Clearance		Wall Thickness-Standard②
	Desired	Allowable		Desired	Allowable	
390	0.001-0.0015	0.001-0.003	0.0755-0.0760	0.0010-0.0015	0.008-0.020	0.0955-0.0960
428 CJ	0.0015-0.0025	0.001-0.003	0.0752-0.0756			
428 Police	0.001-0.002	0.001-0.003			0.0005-0.0025	

①0.002 U.S. Thickness
390 & 428 ..... Add 0.0010 to Standard Thickness

②0.002 U.S. Thickness ..... Add 0.0010 Standard Thickness

CA1057-A16

CONNECTING ROD

Engine	Piston Pin Bore Or Bushing I.D.①	Connecting Rod Bearing Bore Diameter ②	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total②		Connecting Rod Assembly (Assembled To Crankshaft)	
				Twist	Bend	Side Clearance	Wear Limit
390	0.9752-0.9755	2.5907-2.5915	6.486-6.490	0.012	0.004	0.010-0.020	0.023
428							

①Piston pin bushing or bore
Maximum out-of-round
390, and 428 ..... 0.0004
Maximum taper
390, and 428 ..... 0.0003

②Connecting rod bearing bore maximum out-of-round and taper (All Engines)...0.0004
③Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.

CA1057-A17

PISTON

Engine	Diameter①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width	
	Coded Red	Coded Blue	0.003 Oversize				
390	4.0481-4.0493	4.0493-4.0505	4.0505-4.0517	0.0013-0.0023	0.9752-0.9755	Upper Compression Ring All Engines.....	0.080-0.081
428	4.1284-4.1290	4.1296-4.1302	4.1308-4.1314	0.0015-0.0023		Lower Compression Ring 390, 428	0.096-0.097
						Oil Ring All engines.....	0.1880-0.1890

①Measured at the piston pin bore centerline at 90° to the pin bore.

CA1057-A18

PISTON PIN

Engine	Diameter				To Piston Clearance	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
390	3.150-3.170	0.9750-0.9753	0.9760-0.9763	0.9770-0.9773	① 0.0001-0.0003	① 0.0001-0.0003
428	3.165-3.175					

①Wear Limit 0.0008 ②Interference Fit

CA1057-A19

PISTON RINGS

	Ring Width		Side Clearance			Ring Gap Width		
	Compression Ring		①Compression Ring		Oil Ring	Compression Ring		Oil Ring ②
	Top	Bottom	Top	Bottom		Top	Bottom	
390	0.077-0.078	0.093-0.094	0.002-0.004	0.002-0.004	Snug			0.015-0.055
428	0.077-0.078	0.077-0.078				0.010-0.020	0.010-0.020	0.010-0.035

①Wear Limit (All Engines) ..... 0.006 ②Steel Rail

CA1057-A20

OIL PUMP

Engine	Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
390	8.7 - 9.5 @ 1.56	0.0015-	0.0015-	0.0011-	0.006-
428	11.1 - 11.8 @ 1.56	0.0029	0.0029	0.0041	0.013

CA1057-A21

APPROXIMATE OIL PAN CAPACITIES①

Engine	U.S. Measure	Imperial Measure
390	5 Quarts	4 Quarts
428	5 Quarts	4 Quarts
①Includes one quart with filter replacement		

CA1057-A22

TORQUE LIMITS

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel To Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
390, 428	70	80	80-90	10-12	32-35	18-24	12-15	15-18	75-85

CA1057-A23

TORQUE LIMITS

Engine	Oil Inlet Tube To Oil Pump	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter Or Cylinder Block	Cylinder Front Cover
390–428	12-15	95–105	15–20	20–25	9–12	14–19	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	12–15

CA1057-A24

TORQUE LIMITS (Continued)

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
390	20-25	35-45	12-15	70-90	40-45	4-7
428					53-58	

CA1057-A25

TORQUE LIMITS (Continued)

Engine	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper Bolts	Air Manifold To Cylinder Head-Thermactor	Check Valve To Air Manifold Or Supply Tube-Thermactor	Adjusting Arm To Air Pump-Thermactor	Air Pump Mounting Bolts-Thermactor	Air Pump Drive Pulley To Pump Hub Thermactor
390	20-24	UBS Bolts 25-35 Place Bolts 35-45	16-19	16-19	16-20	16-26	7-9
428							

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TORQUE LIMITS (Continued)

Engine	Valve Rocker Shaft Support To Cylinder Head	Valve Rocker Arm Stud To Cylinder Head	Valve Push Rod Chamber Cover	Valve Rocker Arm Adjusting Nut
390	40-45			
428		NA	NA	NA

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ENGINE SUPPORT TORQUE LIMITS–FT. LBS.

Supports	Ford-Mercury-Meteor 390-428	Cougar-Mustang 428
ENGINE FRONT SUPPORTS		
Front Insulator to Engine	35-50	
Front Support Insulator Bracket to Engine		35-60
Front Support Insulator Bracket to Insulator		30-50
Front Insulator to Support Bracket	45-60	20-30
Front Insulator to Mounting Bracket		
Support Bracket to Mounting Bracket		20-30
Support Bracket to Frame	20-30	
Support Bracket to Crossmember		
Mounting Bracket to Frame		20-30
Crossmember Assembly to Frame		45-60
Insulator to Frame Bracket Through Bolt (Nut)		

Supports	Ford-Mercury-Meteor 390-428	Cougar-Mustang 428
ENGINE REAR SUPPORTS		
Rear Support Assembly to Transmission	40-50	30-45
Insulator Assembly to Transmission: Standard / Automatic		
Insulator to Crossmember		
Rear Support Assembly to Crossmember	20-30	25-35
Crossmember to Frame	70-100	10-20
Frame Bracket to Frame Rail Nuts		
Block Bracket to Block Bolts		
Insulator to Extension Housing Bolts		
Crossmember to Frame Side Rail Nut		
Front Insulator Assembly to Block Attaching Bolts		

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THERMACTOR DRIVE BELT TENSION

New	140 Lbs.	Used (any belt operated over 10 minutes)	110 Lbs.

LUBRICANTS

	Ford Part No.
Exhaust Control Valve Lubricant	COAZ-19A501-A, R-149-A

SEALERS

	Ford Part No.
Loctite (thread locking compound)	C3AZ-19554-A

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TORQUE LIMITS FOR VARIOUS SIZE BOLTS

CAUTION: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.

Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-7	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

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